Original Article

Thoracic Central Venous Occlusion in Patients Without History of Central Vein Catheterization

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Background: Thoracic central vein occlusion (TCVO) was a common problem in hemodialysis dependent patients. The major cause of TCVO is due to hemodialysis catheter, but the data of TCVO in patients without any history of previous catheterization in Asia is very limited.

Materials and Methods: The authors collected data from computed tomographic venography (CTV) between January 2010 and December 2012. Patients that had clinical TCVO performed CTV were included consecutively. Baseline clinical data, the history of hemodialysis catheter placement, and CTV findings were recorded and analyzed.

Results: Seventy-six patients were enrolled in the present study. Patient with previous hemodialysis catheterization in central vein had statistically significant higher incidence of TCVO (6.93 times) than those without history of hemodialysis catheter placement ($p<0.0001$). Twenty-two TCVO were found in the vein, which had hemodialysis catheter placed previously. In this group, CTV reveal external compression by aortic branch or aortic dissection in six patients.

Conclusion: History of central venous cannulation was strongly associated with TCVO. However, TCVO could be found in patients who did not have a history of central vein catheterization. The external compression by aortic branch and dissection was also a cause of TCVO.

Keywords: Thoracic central venous occlusion, Aortic dissection, Central line catheterization, Arm swelling

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In the past, hemodialysis catheter insertion was believed to be a major cause of Thoracic central vein occlusion (TCVO)[1-6]. Catheters inserted in the sub-clavian vein had more risk to TCVO than those inserted in the internal jugular vein[1-3]. Hence, a policy was developed to insert hemodialysis catheter only in the internal jugular vein. However, when following this policy, the incidence of TCVO was not zero[3,7,8]. In many studies, TCVO in hemodialysis dependent patients happened even if the patients had no history of catheter insertion[3,7-9]. Several theories were proposed to these findings, for examples, some proposed that arteriovenous access (AV access) in the arm created the high flow (turbulence) of blood through the central vein and then caused injury and stenosis-occlusion eventually[1,3,5,7,9-11]. The left brachiocephalic vein (BV) was compressed between the sternum and left sub-clavian artery or aortic arch[8,9]. In another theory, the sub-clavian vein was compressed by surrounding tissue in the thoracic outlet space (space between clavicle and first rib)[8,10]. However, data based on Asia population is very limited. The present study at Maharaj Nakorn Chiang Mai Hospital aimed to find the incidence of non-catheter related TCVO and its cause.

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Materials and Methods

The authors retrospectively reviewed patients at Maharaj Nakorn Chiang Mai Hospital, which is the

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university tertiary referral hospital in the Northern region of Thailand. The present study collected all patients from the computed tomographic venography (CTV) results between January 2010 and December 2012. Patients who were performed CTV due to clinically suspected TCVO following AV access placement were enrolled in the present study. The demographic data including age, sex, and underlying disease were collected. The specific data such as presenting symptoms, the detail of AV access creation, side of hemodialysis catheter and correlation to side of TCVO, and duration of AV access from creation to development of symptom was recorded. The symptoms included edema of extremity, tenderness of extremity, venous dilatation of the chest wall, hyperpigmentation, and central nervous system symptom. The CTV images were evaluated by a radiologist in the present center. The present study was approved by the Ethic Committee of the Faculty of Medicine, Chiang Mai University.

Statistical analysis

The demographic data were collected and calculated into mean, and percentage. Risk factors of TCVO were analyzed by using Chi-square test. A p-value less than 0.05 was considered statistically significant. All statistical analyses were performed by using Stata version 10.1 (StataCorp 2005, Stata Statistical Software: Release 10.1; StataCorp LP, College Station, Texas).

Results

Seventy-six patients (152 sides of thoracic central vein side) were enrolled in the present study and included 40 males (52.6%). The age varied from 20 to 87 years with a mean age of the study group of 62.59 years. Underlying diseases were composed of hypertension in 62 patients (81.6%), diabetes mellitus in 24 patients (31.6%), gout in 19 patients (25.0%), and dyslipidemia found in nine patients (11.8%) (Table 1).

TCVO occurred in various site. BV showed a high incidence for stenosis with 62 patients (81.6%). Subclavian vein stenosis was seen in 17 patients (22.4%), whereas it was uncommon in the internal jugular vein, and superior vena cava. TCVO contributed to many symptoms, such as edmatous extremity in 37 patients (48.7%), venous engorgement in chest wall in 14 patients (18.4%), and arm pain in 11 patients (14.5%). Thirty-four patients (44.7%) were asymptomatic (Table 1).

The history of previous hemodialysis catheter placement had significantly higher percentage of TCVO than those without (6.93 times, p<0.0001) (Table 2). There were 22 patients without history

Table 1. Demographic data

	n (%)
Age (years)	
Range	20 to 87
Mean±SD	62.59±14.48
Sex	
Male	40 (52.6)
Female	36 (47.4)
Location of TCVO	
Brachiocephalic vein	62 (81.6)
Subclavian vein	17 (22.4)
Cephalic arch	8 (10.5)
Internal jugular vein	6 (7.9)
Superior vena cava	5 (6.6)
Symptom from TCVO	
Extremity edema	37 (48.7)
Failed AVF	34 (44.7)
Venous engorgement	14 (18.4)
Pain	11 (14.5)
Hyperpigmentation	4 (5.3)
Post-hemodialysis clotting delay	3 (3.9)
Underlying diseases	
Hypertension	62 (81.6)
DM	24 (31.6)
Gout	19 (25.0)
Dyslipidemia	9 (11.8)

SD=standard deviation; TCVO=thoracic central vein occlusion; AVF=arteriovenous fistula; DM=diabetes mellitus

Table 2. The association between the history of central catheter placement and the finding of thoracic central vein occlusion by CT venogram

	Presence the history of previous catheter placement	Absence the history of catheter placement
	n (%)	n (%)
Presence TCVO	69 (78)	22 (34)
Absence TCVO	19 (22)	42 (66)

TCVO=thoracic central vein occlusion; CI=confidential interval
Odds ratio 6.93, 95% CI 3.17 to 15.28, p<0.0001

Table 3. The clinical and demographic profiles of the 22 patients who had TCVO without a history of previous catheter placement

Patient No.	Stenosis	Age (years)/ sex	Duration of AVF in the same side of TCVO (months)	Symptom	Specific cause of external compression
1	Rt BV + Rt IJV	72/M	12	Failed AVF	
2	Lt BV	70/M	10	Pain and edema of Lt arm + post hemodealysis delay clotting	
3	Lt BV + Lt SCV	77/M	12	Lt arm edema	External compression from aortic dissection
4	Rt BV + Lt BV	77/M	11	Failed AVF	
5	Rt BV	62/F	12	Venous engorgement + pain and edema of Rt arm	
6	Rt SCV	76/F	48	Rt arm edema	
7	Lt BV	72/F	0	Lt arm edema	Aortic branch compression
8	Rt cephalic arch	71/M	36	Failed AVF	
9	Rt BV + Lt BV	65/F	12	Venous engorgement + pain and edema of Lt arm	
10	Rt SCV	78/M	12	Failed AVF	
11	Lt BV + Lt SCV	76/M	96	Failed AVF	
12	Lt BV	40/F	84	Lt arm edema	Aortic branch compression
13	Rt SCV + Lt SCV	87/M	0	Failed AVF	
14	Rt SCV + Lt SCV	60/F	84	Failed AVF	
15	Rt BV + Rt cephalic arch + Lt BV	81/M	24	Failed AVF	Aortic branch compression
16	Rt BV + Lt cephalic arch	60/F	108	Failed AVF	
17	Lt BV + SCV	64/M	0	Failed AVF	
18	Rt cephalic arch + Lt cephalic arch	58/F	48	Failed AVF	
19	Rt cephalic arch + Lt BV	62/M	60	Venous engorgement and edema of Rt arm	
20	Rt cephalic arch + Lt SCV	51/F	96	Pain and edema of Lt arm	
21	Rt BV + Lt BV	71/F	204	Failed AVF	Aortic branch compression
22	Lt BV	76/F	0	Failed AVF	Aortic branch compression

TCVO=thoracic central vein occlusion; Rt=right; Lt=left; BV=brachiocephalic vein; IJV=internal jugular venous; SCV=subclavian vein; AVF=arteriovenous fistula; M=male; F=female

of central venous catheterization on the side that developed clinically TCVO (Table 3). Bilateral stenosis was found in 10 patients (No.4, 9, 13, 14, 15, 16, 18, 19, 20, and 21). TCVO caused by external compression in six cases (aortic branch compression in five cases and aortic dissection compression in one case).

Discussion

TCVO is not a rare problem in patients on hemodialysis and can even occur without previous placement of central venous catheter. The present study found such TCVO in 22 cases (22/76=28.94%). In the present study, the compression from aortic branch and aortic dissection could lead to TCVO.

The present study found central vein catheterization caused TCVO 6.93 times higher than those without history of central vein catheterization. Indeed, the avoidance of central venous catheterization should be encouraged. Patients in the present center had a history of central catheterization 85%, although the authors' health authority kept this percentage lower than 20% according to international guideline[12,13]. This might due to late treatment in renal insufficiency. Patients usually come with heart failure, so the only option for renal replacement therapy was emergency

hemodialysis through central vein catheterization. There have been a lot of such barriers for early AV access creation not only late diagnosis of renal insufficiency, but also attitude of patients to surgery and interdisciplinary communication problems between surgeons and nephrologists were also identified as a major barrier. The policy of pre-dialysis education to moderate renal insufficiency patients and good communication between surgeons and nephrologists (as a multidisciplinary team) might partially solve this issue. In case of late resolution, the physician may avoid central cannulation by application of peritoneal dialysis, while waiting maturation of AV access in the arm. In addition, ideally, the physician should reduce the incidence of diabetes, which is a common cause of renal insufficiency in Thailand. However, the situation of diabetes occurrence in Thailand is now even worse because the prevalence of diabetes has been growing. This trend does not seem to reach any plateau phase. Based on the National Health Survey in Thailand, the prevalence was changed from 6.9% in 2009 to 8.9% in 2014[14]. Therefore, they are still a long way to go to reduce diabetes and consequent renal failure in Thailand.

The etiology of TCVO remains complex and is likely related to many factors. Firstly, mechanical injury from either repeated catheter insertion or continuous catheter movement inside the vein result in endothelial injury, inflammatory reaction, intimal hyperplasia, and scaring process (fibrosis). This is even worse in the present data as some retained central catheterization for a few years before seeking the AV access creation service[12]. Secondly catheter or AV access related changes in the flow dynamics cause increased shear stress, platelet accumulation, and intimal hyperplasia. This might explain the main cause of TCVO without any previous history of central line catheterization (16/22 cases). The remaining cases were due to external compression (Table 3). Interestingly, a combination of the previous two factors might cause TCVO faster.

It is interesting to note that 22/152 (14.5%) of central venous stenosis did not have any history of hemodialysis catheter insertion. In these groups, there is a high incidence of left BV compression by external cause, such as brachiocephalic artery or aortic arch (Figure 1). In the present study, aortic dissection was the cause of compression and this was never previously mentioned (Figure 2).

Limitation

The present study was a retrospective study, prone to bias and error. In addition, the present study was conducted in a tertiary hospital, so the prevalence might not reflect the figure in the community.

Figure 1. Left brachiocephalic vein was compressed by aortic arch.

Figure 2. Left brachiocephalic vein was compressed by aortic dissection.

Conclusion

Major cases of TCVO following AV access were developed in patients who had a history of hemodialysis catheter insertion. However, TCVO can occur in patients who did not have any history of catheter placement. One cause is external compression by aortic branch and aortic dissection.

What is already known on this topic?

So far, the causes of TCVO in patients with arteriovenous access are mostly due to previous central line cannulation. However, the cause of TCVO in the central veins that have never been cannulated were not identified properly.

What this study adds?

The present study added the cause of TCVO in the central veins that had never been cannulated. These include aortic dissection and arterial compression from aortic branches.

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Conflicts of interest

The authors declare no conflict of interest.

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