Original Article

Correlation Between Hand Ischemia Questionnaire and Peak Systolic Velocity of Radial Artery and Ulnar Artery in Hemodialysis Patients with Upper Arm Native Fistula Arteriovenosa

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Introduction: Steal syndrome that occurs due to vascular access is one of the most feared complications after making a fistula arteriovenous (FAV). It is necessary to develop an assessment for early detection. Hand ischemia questionnaire (HIQ) and measurement of peak systolic velocity (PSV) of the radial artery and the ulnar artery are a form of subjective and objective examinations used to detect steal syndrome. The aim is to determine the correlation between HIQ and PSV of the radial artery and ulnar artery in hemodialysis patients with upper arm's native FAV to detect symptoms of steal syndrome.

Method: This is a cross-sectional study conducted in Cipto Mangunkusumo National Hospital from March to May 2019. Patients undergoing hemodialysis using upper arm native access FAV with or without symptoms of ischemia in the hands were included. Patients were asked to fill HIQ by interview, and then continued with measurement of PSV of the radial arteries and distal ulnar arteries from the hands with FAV.

Results: A total of 80 samples were taken with 43 were women (53.8%), and 37 were men (46.2%). About 91.2% of the samples were FAV at the brachiocephalic level. The median age of the samples was 53 years. From the total HIQ score obtained, the results were a minimum of 0, maximum of 70, and a median value of 3. PSV of radial artery were minimum of 20 cm/s, maximum of 79 cm/s, and median 40 cm/s. The minimum PSV of the ulnar artery was 16 cm/s, the maximum was 70 cm/s, and the median was 41 cm/s. There was a significant correlation between the hand ischemia questionnaire and the peak systolic velocity of the radial artery and the ulnar artery in patients with native upper arm FAV (p <0.001), but after diagnostic testing, it was found that sensitivity was only 15% and specificity was 100%.

Conclusion: There was a significant correlation between hand ischemia questionnaire and peak systolic velocity of the radial artery and ulnar artery in patients with upper arm native FAV, but due to the low sensitivity, the hand ischemia questionnaire cannot be used as an initial examination to detect steal syndrome in patients with no symptoms of hand ischemia.

Keywords: steal syndrome, Peak Systolic Velocity, Hand Ischemia Questionnaire.
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INTRODUCTION

Chronic kidney disease (CKD) is a global health problem, with an estimated prevalence of 8% to 16%.[1] Data from the Indonesian Renal Registry in 2017 recorded 77,892 patients actively undergoing hemodialysis procedures, with 30,831 of whom are new patients.[2]

One of the hemodialysis procedures that is often used is fistula arteriovenous (FAV). FAV in the upper arm uses the brachial artery as a feeding artery, consisting of brachiocephalic, brachiobasilic, and FAV, which uses loop graft as artificial vein draining and connected to the brachial artery.[3] The diameter of the brachial artery, cephalic and basilica veins in the upper arm are greater than the diameter of the radial artery and cephalic vein in the wrist area, thereby increasing the maturity and patency rates of the upper arm FAV which is higher than the forearm FAV.[4-8]

One of the most feared complications of upper arm FAV is the occurrence of ischemic

symptoms in the distal segment of the fistula, or more commonly referred to as arteriovenous access ischemic steal (AVAIS) or steal syndrome.[9] The incidence of steal syndrome in upper arm access varies between 2% to 8%, with several systematic review studies found that clinical symptoms of steal syndrome occur in 10-25% for upper arm fistulas that use cephalic or basilic veins and as much as 4.3-6% for upper arm fistula that uses graft (arteriovenous graft/AVG). This is correlated with the more diameter, the more incidence of steal syndrome. Symptoms that appear can pain that initially only arises during hemodialysis, a cold sensation on the hands, and feels numb. In the advanced stages, the pain will be more painful and persist until ulcers and gangrene arise on the hands.[9,10]

Hand Ischemia Questionnaire (HIQ) is a questionnaire to detect the initial symptoms of steal syndrome in hemodialysis patients with/without complaints of ischemia on the hands.[11] There are questions that consist of subjective symptoms of stealing syndrome, which are cold sensation, pain, sensitivity, strength, and cramps. Also, objective examinations can be performed with Doppler ultrasound by measuring peak systolic velocity (PSV).

Research in Indonesia related to stealing syndrome is still very limited. This study aims to determine the correlation between HIQ and PSV measurement in patients with Brachial FAV.

METHOD

This research is a cross-sectional study conducted at the Polyclinic Division of the Vascular, Department of Surgery, Cipto Mangunkusumo National Hospital, Jakarta, in the period of March-May 2019.

The inclusion criteria in this study were all patients who underwent dialysis with brachiocephalic or brachiobasilic fistula access. Patients with cognitive impairment were excluded. HIQ assessment was carried out with guided interviews, and peak systolic velocity was assessed by Doppler ultrasound (iuStar100, United Imaging, Beijing, China) with a linear probe. The probe was placed longitudinally in the direction of the long axis of the arm and the radial artery and the ulnar artery, using B-mode. After finding the radial artery, the long axis was assessed whether there was narrowing or not, and then the color mode was used to detect blood flow. The PW mode was used to assess PSV by placing the steer volume right in the middle of the lumen of the blood vessel and in the direction of the blood vessel with angle steer of <60°. After that, using the automatic measurement method available in the "measure" menu, the PSV value was determined. Data were analyzed using SPSS version 24.0 for Windows®.

RESULTS

In total, there were 80 samples in this study. Male patients were 37 (46.2%), and women were 43 (53.8%) with a mean age of 53 years. The most common type of fistula was 73 (91.2%) brachiocephalic and 7 (8.7%) brachiocephalic

patients. The most common contributing factors for chronic kidney disease were hypertension in 70 (87.5%) patients, diabetic nephropathy in 20 (25%) patients, nephrotic syndrome in 8 (10%) patients, and polycystic kidney disease in 2 (2.5%) patients (table 1).

Table 1. Patients characteristics.

Characteristics	n = 80
Gender	
Male	37
Female	43
Age, median (min-max)	53 (14-77)
FAV type	
BC sinistra	73
BC dextra	7
Postoperative month, median (min-max)	27 (6-118)
Causes of CKD	
Diabetic Nephropathy	20
Hypertension	70
Polycystic Kidney Disease	2
Nephrotic Syndrome	8

Based on the characteristics, the minimum value of HIQ was 0 and a maximum of 70, with a median of 3. In the FAV of the radial artery, the result of PSV was a minimum of 20 cm/s, a maximum of 79 cm/s, with a median of 40 cm/s. In the ulnar, the results of PSV were a minimum of 16 cm/s, a maximum of 70 cm/s, with a median of 41 cm/s (table 2).

Table 2. Characteristics of HIQ and PSV values of radial and ulnar artery

	Median	Min	Max	Range
Cold	0	0	19	19
Pain	0	0	17	17
Sensibility	0	0	18	18
Motor	0	0	18	18
Cramp	0	0	20	20
Total HIQ	3	0	70	70
PSV radial a. AF	40	20	79	59
PSV ulnar a. AF	41	16	70	54

HIQ: Hand Ischemic Questionnaire; AF: Arm Fistula

It shows that there was a correlation between HIQ and the PSV of the radial and the ulnar artery examined on the side of the fistula (r = -0.7, p <0.001) **(table 3).**

Table 3. Correlations between HIQ with PSV of radial and ulnar artery

Correlation between HIQ and PSV		Total HIQ
PSV radialis a. AF	r	-.771**
	p	.000
PSV ulnaris a. AF	r	-.780**
	p	.000

From the comparison table of HIQ examination and radial arterial PSV, using cut-off below and above 40 cm/s, it was found that in PSV results of <40, 34 patients who were categorized as normal and normal variations and only 6 patients were suggestive for steal syndrome based on HIQ Score. On the results of the PSV examination ≥40 cm/s, there were 40 patients in the normal category and normal variations, and there were no patients in the category of suggestive steal syndrome (table 4).

Table 4. Comparison of HIQ and PSV results of radial artery above and below 40.

| | | PSV radial artery | | | |
| | | <40 | | ≥40 | |
		n	%	n	%
Cold	normal	18	31.0%	40	69.0%
	abnormal	22	100.0%	0	0.0%
Pain	normal	29	42.0%	40	58.0%
	abnormal	11	100.0%	0	0.0%
Sensibility	normal	24	37.5%	40	62.5%
	abnormal	16	100.0%	0	0.0%
Motor	normal	24	37.5%	40	62.5%
	abnormal	16	100.0%	0	0.0%
Cramps	normal	25	38.5%	40	61.5%
	abnormal	15	100.0%	0	0.0%
HIQ	normal	0	0.0%	40	100.0%
	normal variation	34	100.0%	0	0.0%
	suggestive steal syndrome	6	100.0%	0	0.0%

Table 5. Comparison of HIQ and PSV results ulnar artery above and below 40.

| | | PSV radial artery | | | |
| | | <40 | | ≥40 | |
		n	%	n	%
Cold	normal	18	31.0%	40	69.0%
	abnormal	21	95.5%	1	4.5%
Pain	normal	28	40.6%	41	59.4%
	abnormal	11	100.0%	0	0.0%
Sensibility	normal	23	35.9%	41	64.1%
	abnormal	16	100.0%	0	0.0%
Motor	normal	23	35.9%	41	64.1%
	abnormal	16	100.0%	0	0.0%
Cramps	normal	24	36.9%	41	63.1%
	abnormal	15	100.0%	0	0.0%
HIQ	normal	0	0.0%	41	100.0%
	normal variation	33	100%	0	0.0%
	suggestive steal syndrome	6	100.0%	0	0.0%

From the comparison table of HIQ examination results with PSV of the ulnar artery, using a cut-off below and above 40 cm/s, it was found that on PSV examination of <40, 33 patients who were categorized as normal and normal variations and 6 patients were suggestive for steal syndrome based on HIQ score. On the results of the PSV examination of ≥40 cm/s, there were 41 patients in the normal category and normal variations, and there were no patients in the category of suggestive for steal syndrome (table 5).

PSV value of radial and ulnar artery using a cut-off value of <40 cm/s. The sensitivity value was 15%, and the specificity value was 100% for the diagnostic test results between the HIQ score and the radial artery PSV, and diagnostic accuracy of 57.5%. From the diagnostic test results between the HIQ score and the ulnar artery PSV using the same cut-off value obtained a sensitivity value of 15.38% and a specificity value of 100%, and a diagnostic accuracy of 58.75%. This can be interpreted that if HIQ scores ≥50 and PSV scores are obtained (tables

Table 6. Diagnosis Test between HIQ (<50 and >50) against radial arterial PSV

| | | PSV radial artery | | |
		< 40	> 40	Total
HIQ	> 50	6	0	6
	< 50	34	40	74
		40	40	80

Parameter	Estimate	Lower - Upper 95% CIs	Method
Sensitivity	15%	(7.061, 29.07[1])	Wilson Score
Specificity	100%	(91.24, 100[1])	Wilson Score
Positive Predictive Value	100%	(60.97, 100[1])	Wilson Score
Negative Predictive Value	54.05%	(42.78, 64.93[1])	Wilson Score
Diagnostic Accuracy	57.5%	(46.57, 67.74[1])	Wilson Score

A diagnostic test was performed between the HIQ Score using a cut-off value of ≥50 with a

6 and 7).

Table 7. Diagnostic tests between HIQ (<50 and> 50) against PSV of the ulnar artery

		PSV A. ulnaris		
		< 40	> 40	Total
HIQ	> 50	6	0	74
	< 50	33	41	6
		39	41	80

Parameter	Estimate	Lower - Upper 95% CIs	Method
Sensitivity	15.38%	(7.247, 29.73[1])	Wilson Score
Specificity	100%	(91.43, 100[1])	Wilson Score
Positive Predictive Value	100%	(60.97, 100[1])	Wilson Score
Negative Predictive Value	55.41%	(44.09, 66.18[1])	Wilson Score
Diagnostic Accuracy	58.75%	(47.8, 68.89[1])	Wilson Score

DISCUSSION

Based on the data obtained from the total score of the Hand Ischemia (HIQ) questionnaire, the minimum value was 0, and the maximum value was 70, with a median value of 3. This finding was much lower when compared to previous studies conducted by Roel et al.[11] in patients who already have symptoms related to Steal syndrome, HIQ scores were a median of 275, a minimum value of 200, and a maximum value of 311. However, in the population of patients undergoing hemodialysis without any symptoms associated with steal syndrome, the results were similar to the minimum value of 0, the maximum value of 41.5, and the median value of 13.5. Compared with previous studies, the value of the HIQ score in patients without initial symptoms suspected of being related to Steal syndrome would be lower than for symptomatic patients.

One of the challenges was filling out the questionnaire. Of the five-question points on the HIQ questionnaire, the most difficult to understand by patients was the question about reduced motor strength. Patients with FAV automatically reduce the use of the arm with FAV for physical activity, so when asked if there was a reduction/weakness in strength motor related to the symptoms of steal syndrome, the patient could misinterpreted by the strength of the FAV arm muscles that were not used for physical activity. Furthermore, after examination of the HIQ score, all patients were examined to measure the value of the PSV of the radial and ulnar arteries of the side of the fistula by using a doppler ultrasound. From the results of this examination, it was obtained the characteristics of the radial artery arm fistula with a median value of 40, a minimum value of 20, and a maximum of 79. For ulnar artery arm fistula, the results were a median value of 41, a minimum value of 16, and a maximum of 70. The value obtained was almost similar to the study by Roel et al.[11], with a median PSV value of the radial and ulnar arteries ranging from 40-43 cm/s. There was no significant difference between PSV of the radial and ulnar, in patients with a high HIQ score> 50 with a lower PSV value of <40 cm/s compared to patients with a low HIQ score less than 50.

When a correlation test was performed between the total score of the HIQ questionnaire with radial and ulnar PSV scores, there was a strong and significant correlation (r >-0.7 p <0.001). These results were consistent with the initial hypothesis in this study, with the higher HIQ questionnaire scores, the lower PSV values will be.

The sensitivity value obtained on the HIQ score against PSV in this study was found to be low due to the HIQ clinically is still said to be normal and normal variations from the score of 0-49, while PSV values were at <40cm/s. On the other hand, the specificity value obtained was very high, because when HIQ clinical values were said to be suggestive of steal syndrome (score ≥50), all PSV values of the radial and ulnar artery were obtained <40 cm/s.

Based on this study, it can be said that the HIQ questionnaire cannot be used as a tool for early detection of stealing syndrome in a population of hemodialysis patients with upper arm FAV without ischemic complaints at hand. However, in patients who already have ischemic complaints, this questionnaire can be used because it has high specificity. This also has been proven in several previous studies[9-11].

CONCLUSION

There was a significant correlation between HIQ scores and PSV of radial and ulnar arteries in patients who have undergone hemodialysis using upper arm native fistula to detect symptoms of steal syndrome. The sensitivity of the HIQ diagnostic test was very poor, but it has excellent specificity to diagnose steal syndrome in patients with a complaint of ischaemic hand.

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