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ORIGINAL ARTICLE

Vascular Access Surgery for Hemodialysis and Ischemic Monomelic Neuropathy: Presentations of the Patients Clinically, Electrodiagnostic Correlations and its Management

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ABSTRACT

Background: Ischemic monomelic neuropathy is an uncommon condition observed in end stage renal disease or hemodialysis patients undergoing arteriovenous fistula graft surgery.

Objective: To assess the clinical electrodiagnostic and management strategies of patients undergoing arteriovenous fistula surgical graft leading to ischemic monomelic neuropathy.

Study Design: Retrospective study

Place and Duration of Study: Department of Cardiothoracic Surgery, Shaikh Zayed Hospital, Lahore from 1st May 2023 to 31st October 2023.

Methodology: One hundred and three patients presented with fore limb weakness after AV fistula graft surgery were enrolled within the age of 45-70 years. The inclusion criteria of the patients were based on medical history of end stage renal disease, hemodialysis, diabetic or no diabetes as well as clinical complaints including clumsiness, pain and limb weakness post brachiocephalic vascular graft surgery. Each patient underwent neurological assessment/examination and the intensity of weakness was recorded with the sensory involvement and loss. The nerve distribution involved was documented through Nerve conduction studies (NCS) of the limb extremity wherein the reduction in the motor amplitudes of the involved nerves was recorded. The sensory amplitudes were observed. The needle EMG (electromyography) of the limb was performed which presented the denervation affects leading to multiple intrinsic muscles supplied by nerves. Radiological examination using Doppler ultrasound studies was conducted presenting the presence of any evidence related to vascular steal phenomenon. Arteriovenous fistula ligation was performed (Vascular ligation) in 95 cases while rest 4 each had banding and angioplasty performed.

Results: The mean age of the patients was 56.5±4.3 years with majority of the cases were between the age group of 61-70 years. The higher prevalence of females than males undergoing surgery for arteriovenous fistula was found. The clinical symptoms of the patients included majority of the cases to have pain and edema while numbness and paralysis was observed in the cases upto 84.46% and 86.40% respectively. The management of the cases showed that 95/103 cases underwent AV fistula ligation with ulnar artery repair in few cases whereas other treatment methods which were applied included 3.8% of the patients undergoing banding or ligation. The highest improvement in blood supply and grip strength was observed in the AV fistula ligation cases. Nerve conduction studies (NCSs) showed absent sensory responses from the left median, ulnar and radial nerves. Electromyography (EMG) showed fibrillation potentials and positive sharp waves in the small muscle of the forelimbs, which indicated active denervation in keeping with an acute nerve lesion.

Conclusion: The major clinical symptoms include pain, edema, numbness and paralysis. The diagnosis and treatment of the condition requires electrography, radiological assessment followed by AV fistula ligation for the improvement of blood supply. There is higher efficacy of the AV fistula ligation management procedure than banding or angioplasty in IMN cases.

Keywords: Vascular access surgery, Hemodialysis, Ishcemic monomelic neuropathy, Electrodiagnostic

INTRODUCTION

Ischemic monomelic neuropathy (IMN) is a rare condition observed post arteriovenous (AV) fistula-graft surgery. Pathognomy is the main reason of IMN leading to impaired supply of the blood.[1] The symptoms observed in patients with IMN include acute pain, paresthesia and numbness in addition to the motor-weakness. These features are highly prevalent in patients suffering from brachiocephalic vascular graft.[2] In patients suffering from hemodialysis and end stage renal disease the risk of AV fistula is much higher than other comorbidities.

Arteriovenous fistula is considered as a favored vascular access type for hemodialysis.[3-6] After the establishment of AV fistula, the risk of complications is minimal with longer potency in comparison with the arteriovenous-grafts as well as catheters.[7,8] In the recent years the increasing elderly proportion on hemodialysis has led to an ascend in the failure to mature rate as well as have decreased the patency rate.[9] It is significant to note that patient care is dependent on the individual approaches to the therapy which includes the options of vascular access and balance between risks involved and benefits available.

The complications associated with the AV fistula include morbidities, financial burdens as well as mortality.[10] Despite of the fact that there are various systematic reviews been conducted in context of fistula-patency and failure to mature, however there is limited data available on aneurysm, ischemic steal syndrome, venous hypertension, infection and thrombosis. The present study was conducted in patients suffering from ischemic monomelic neuropathy who had undergone after arteriovenous fistula surgery previously. The clinical features, electrodiagnostic findings and treatment details of such patients were listed down for better understanding of the complications and the most efficient way available for minimizing the risks and increase health outcomes.

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MATERIALS AND METHODS

This retrospective study conducted at Department of Cardiothoracic Surgery, Shaikh Zayed Hospital Lahore from 1st May 2023 to 31st October 2023. A total of 103 patients presented with fore limb weakness after AV fistula graft surgery and age between 45-70 years were enrolled. The ethical clearance of the research was taken from the institutional review board prior initiation of the study. All the patients enrolled were requested to give an informed consent for participation before their induction in the study as participants. The sample size was calculated through the sample size available EPI software using 5% margin of error, 80% power of test and 95% CI. The inclusion criteria of the patients were based on medical history of end stage renal disease, hemodialysis, diabetic or no diabetes as well as clinical complaints

including clumsiness, pain and limb weakness post brachiocephalic vascular graft surgery. Those patients which were suffering from neuropathy or paralysis before the surgical procedure were excluded from the study. The medical record files were studies in detail and all relevant information was extracted for the research. The procedure was performed under local anesthesia and a 4-7 mm tapered PTFE Propaten graft was used. At the conclusion of the case, a palpable radial artery pulse was noted. The duration of pain sensation was kept open from day after surgery until 3-days-surgery. Each patient underwent neurological assessment/examination and the intensity of weakness was recorded with the sensory involvement and loss. The number of limbs involved was also noted. The nerve distribution involved was documented through Nerve conduction studies (NCS) of the limb extremity wherein the reduction in the motor amplitudes of the involved nerves was recorded. The sensory amplitudes were observed. The needle EMG (electromyography) of the limb was performed which presented the denervation affects leading to multiple intrinsic muscles supplied by nerves. Radiological examination using Doppler ultrasound studies was conducted presenting the presence of any evidence related to vascular steal phenomenon. Arteriovenous fistula ligation was performed (Vascular ligation) in 95 cases while rest 4 each had banding and angioplasty performed. The comparison of pain and blood supply improvement, grip strength, reduction in edema was conducted and results were interpreted. A well-structured questionnaire was used for recording all clinical history, symptoms and assessments. Data was analyzed while using statistical software SPSS version 26.0 wherein Chi square tool and Odds Ration was applied for comparing within variable and interpreting the comparable variable. A p value <0.001 was taken as significant.

RESULTS

The mean age of the patients was 56.5±4.3 years with majority of the cases were between the age group of 61-70 years. The demographic details of the patients presented the data with higher prevalence of females than males undergoing surgery for arteriovenous fistula. There was higher percentage of diabetic cases than non-diabetics. Around 95.14% of the cases were suffering from end stage renal disease (Table 1). There were 56% patients with left limb neuropathy while 39% had right limb neuropathy. Rest of the patient (5%) had both limbs neuropathy symptoms (Fig. 1).

Table 1: Demographic and comorbidities distribution among patients (n=103)

Demographics	No.	%
Age (years)		
45-60	23	22.3
61-70	80	77.67
Gender		
Males	45	43.68
Females	58	56.31
Comorbidities		
End stage renal disease	98	95.14
Diabetes	56	54.36
Non diabetics	47	45.63
Hypertension	13	12.62
Coronary artery disease	21	20.38

Table 2: Clinical symptoms of the IMN patients (n=103)

Clinical Symptoms	No.	%	Odds ratio (95% CI)
Tachycardia	74	71.84	0.80
Clumsiness	13	12.62	0.14
Pain	92	89.32	1.02
Numbness	87	84.46	0.94
Cool	62	60.19	0.67
Warm	41	39.80	0.44
Paralysis	89	86.40	0.96
Edema	92	89.32	1.02
2^{+} radial pulse	88	85.43	0.98

Table 3: Management plan used for the treatment of IMN patients

Treatment Plan	AV fistula ligation (n=95)	Banding (n=4)	Angioplasty (n=4)	P value
Pain Improvement	55 (57.89%)	2 (50%)	1 (25%)	>0.001
Blood supply improvement	70 (73.84%)	2 (50%)	1 (25%)	
Reduction in numbness	68 (71.57%)	1 (25%)	1 (25%)	
Grip Strength	56 (58.94%)	2 (50%)	2 (50%)	

Table 4: Electromyography summary of the right hand

MUAP	Recruitment								
	Insertionalactivity	Fibrillations	Positive wave	Fasciculations	Myotonic discharges	Polyphasia	Amplitude	Duration	Recruit
Extensor digitorum communis	Usual	0	0	0	0	0	Usual	Usual	Complete
Deltoid, middle	Usual	0	0	0	0	0	Usual	Usual	Complete
Flexor carpi ulnaris	Usual	0	0	0	0	0	Usual	Usual	Complete
Flexor pollicis longus	Increased	1	1	0	0	0	Usual	Usual	Complete
Pronator teres	Usual	1	1	0	0	0	Usual	Usual	Complete
Abductor pollicis previs	Usual	3	3	0	0	0	Usual	Usual	Compact
First dorsal interossei	Usual	2	2	1	0	0	Usual	Usual	Compact
Biceps brachii	Usual	0	0	0	0	0	Usual	Usual	Complete
Triceps	Usual	0	0	0	0	0	Usual	Usual	Complete

The management of the cases showed that 95/103 cases underwent AV fistula ligation with ulnar artery repair in few cases where as other treatment methods which were applied included 3.8% of the patients undergoing banding or ligation. There was a significant variance among improvement in the pain and blood supply within the various treatment plans. The highest improvement in blood supply and grip strength was observed in the AV fistula ligation cases (Table 3).

Nerve conduction studies (NCSs) showed absent sensory responses from the left median, ulnar and radial nerves. Electromyography (EMG) showed fibrillation potentials and positive sharp waves in the small muscle of the left hand, which indicates active denervation in keeping with an acute nerve lesion (Table 4).

The clinical symptoms of the patients included majority of the cases to have pain and edema while numbness and paralysis was observed in the cases upto 84.46% and 86.40% respectively. Most of the cases had a warm feeling in the neuropathic limb (Table 2). The generation of the clinical symptoms was started at various timings including some within the first two hours of the surgery while others taking more longer period between surgery to the pain generation (Fig. 2).

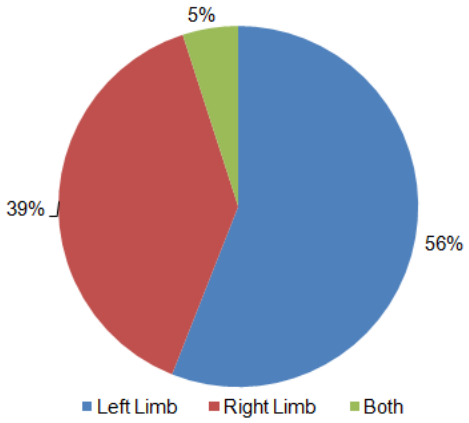

Fig. 1: Information related to limb involvement in ischemic monomelic neuropathy

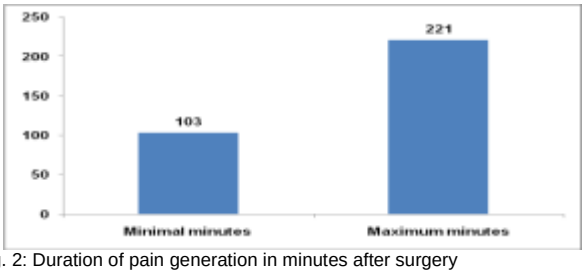

Fig. 2: Duration of pain generation in minutes after surgery

DISCUSSION

Patients suffering from end stage renal diseases, hemodialysis, or any other serious complications require critical care. Patients with the end stage renal disease require dialysis along with AV fistula vascular grafting. The procedure has turned out to be comparatively complicated in terms of development of a rare condition termed as ischemic monomelic neuropathy (IMN). The IMN was primarily elaborated in 1980s.[11,12] Research has demonstrated that majority of the practitioners prefers AV fistula generation than the grafting procedure. The reasons being the involvement of the higher mortality rate in the grafting procedure in comparison to the fistula formation.[13,14] Most of the cases were suffering from end stage renal disease wherein the AV fistula generation was the preferred procedure than grafting. The results of the current research are in harmony with the previously reported data.

The IMN incidence is minimal as 1% in all the vascular-access procedures.[15] The present study results have clearly shown higher incidence of females in developing the IMN condition than males of the same age. The prevalence of diabetes was also much higher among these cases. Research elsewhere has elaborated similar findings with IMN more likely to be existing in females and diabetic patients.[16,17]

The IMN development is associated with the shunting of the blood supply into the distal extremities and into the fistula. The most concerned in development of IMN are brachiocephalic artery-fistulas. The brachial artery is a single artery which is supplying blood to the forearm and hand. The collateral supply to the forearm and the hand is not presented. The larger nerve fibers are abounded through nervocum as well as through localized diffusion of nutrition to the small nerves. The ischemic damage is presented to the larger nerves in cases of IMN.[18,19] The present study also presented the similar findings as literature elaborate that larger nerve involvement in IMN cases results in acute pain, numbness as well as presentation of paresthesia with motor feebleness.[20]

Recent literature supports the application of AV ligation procedure for the treatment of IMN cases after AV fistula surgery. However other procedures including banding and angioplasty have also been applied in some cases.[21] The efficacy of results has been found highest in AV ligation treatment plan than any pf the others treatment procedures. The present study results are in coordination with these research findings.

CONCLUSION

Ischemic monomelic neuropathy is a rare condition post AV fistula surgery and is more prevalent in diabetic females suffering from end stage renal disease or on hemodialysis. The major clinical symptoms include pain, edema, numbness and paralysis. The diagnosis and treatment of the condition requires electrography, radiological assessment followed by AV fistula ligation for the improvement of blood supply. There is higher efficacy of the AV fistula ligation management procedure than banding or angioplasty in IMN cases.

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