Fistula Plication versus Distal Revascularization with Interval Ligation (DRILL) in the management of Dialysis-Associated Steal Syndrome (DASS)

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ABSTRACT

Introduction: *Dialysis-associated steal syndrome (DASS) is a rare with incidence range (1.6% to 8.0%) but important complication with significant impact on limb functionality and viability. Flow-limiting surgical procedures such as anastomotic plication or narrowing of the efferent vein with banding are easy ways of treating DASS.* ***Aim:*** *Aim of this study was to evaluate the technique of controlled blood flow reduction (plication of the anastomosis) in brachial fistulas against DRILL in management of DASS regarding the success of hand revascularization with fistula preservation, duration and complications of the techniques.* ***Patients and methods:*** *This study included 21 patients presented to the vascular surgery department at Cairo University teaching hospitals having dialysis shunt associated steal syndrome with autogenous brachial artery based accesses, between May 2015 and October 2016.* ***Results****: The patients were into two groups; group (1) included nine patients treated with DRILL procedure while group (2); for twelve patients treated with plication of fistula's anastomosis. In case of fistula plication, the blood flow was put down by approximately 50% of the initially measured flow. Time of follow-up was 18 months. Regarding group 1 six patients still undergo hemodialysis via the fistula with normal hand function. Regarding group 2 nine patients still undergo hemodialysis via plicated fistula with normal hand function.*
Conclusion*: We evaluated the plication technique in treatment of DASS that we have established in our institution. We found that fistula plication under blood flow control as easily performable procedure is an adequate therapeutic option in patients with DASS.*
Keywords*: DASS, DRILL, fistula plication*

INTRODUCTION

Dialysis-associated steal syndrome (DASS) is a rare with incidence range (1.6% to 8.0%) but important complication with significant impact on limb functionality and viability. [1, 2]

The steal phenomenon describes the case with only altered hemodynamic flow while steal syndrome describes cases severe enough to require intervention based on the clinical status. [3]

The steal mechanism may be due to retrograde flow out of the peripheral artery [4, 5] or underlying vascular diseases. [4, 6] Although there are several forms of DASS but a general classification, has not yet been established.

*Sidawy et al*graded steal into 4 grades; grade0: No steal, grade 1: (mild) cool extremity and few symptoms with arterial flow augmentation upon access occlusion, grade 2: (Moderate) intermittent ischemia only during dialysis and exercise claudication and grade 3 :(Severe) ischemic pain at rest and tissue loss.

Intervention is not necessary for grades 0 and 1 while it is optional for grade 2 yetit is mandatory for grade 3. [7]

Although no preoperative test can definitively predict occurrence of steal, we should know how to pick up patients at risk.These include elderly patients, history of multiple prior access procedures, significant peripheral arterial occlusive disease or previous vascular surgery, prior history of steal, and diabetics. [8-12]Use of a prosthetic A-V access as well as use of the brachial arterymay also predispose to steal. [13-15]

Treatment can be simple angioplasty of proximal lesions, distal revascularization with interval ligation (DRIL), proximalization of arterial inflow, banding, revascularization using distal inflow (RUDI) or finally access ligation. [16]

Flow-limiting surgical procedures such as anastomotic plication or narrowing of the efferent vein with banding are easy ways of treating DASS, there are only few reports on the outcome of banding. One reason is the inherent problem of balancing fistula flow with distal flow. However

plication can be performed easier by striking a balance between fistula flow and distal flow. [17]

Aim:

Aim of this study was to evaluate the technique of controlled blood flow reduction (plication of the anastomosis) in brachial fistulas against DRILL in management of DASS regarding the success of hand revascularization with fistula preservation, duration and complications of the techniques.

PATIENTS AND METHODS

This study included 21 patients presented to the vascular surgery department at Cairo University teaching hospitals having dialysis shunt associated steal syndrome with autogenous brachial artery based accesses, between May 2015 and October 2016.

Our inclusion criteria included those patients with only autogenous accesses presenting with severe steal, having measurable flow preference into the vein andtheir absent or weak distal pulses can be normalized upon digital fistula occlusion. However patients with ipsilateral peripheral occlusive disease or those with severe hand ischemia not amenable to access preserving surgery were excluded.

All patients had proper history taking and clinical examination with emphasis on peripheral occlusive disease's risk factors, history of fistula surgery, its performance on dialysis and puncture bleeding control upon dialysis session's termination

Following routine laboratory testing, all had detailed duplex study for proper evaluation of their arterial tree and document reversal of flow phenomenon as well exclusion of central vein stenosis/occlusion.

The patients were into two groups; group (1) included patients treated with DRILL procedure while group (2); for those patients treated with plication of fistula's anastomosis.

The procedure, possible complications, benefits, risks and other alternative interventions were all explained to the patients and an informed consent was obtained.

Patients undergoing DRILL were admitted the night before procedure and under general anesthesia they had ligation of the artery distal to the A-V access anastomosisto eliminate flow reversal. Then arterial bypass was carried out with takeoff 7 to 10 cm proximal to the fistula anastomosis with landing distal to the ligated artery by a reversed saphenous vein graft.

While patient scheduled for fistula plication were admitted on day case basis werethey had re-exploration of their fistula under local anesthesia with or without sedation. The procedure included adequate exposure of the fistula's artery and vein long enough to allow for safe tension free clamping.

Narrowing of the anastomosis was achieved byinterrupted polypropylene sutures at its distal end (toe of the anastomosis).**Figure 1, 2**

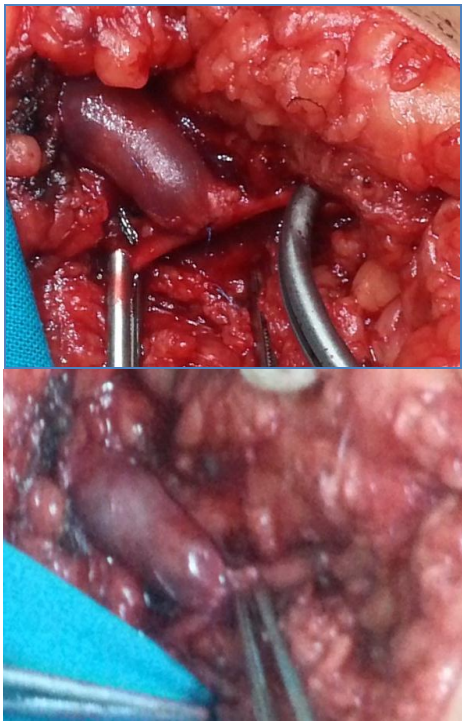

Figure :(1) anastomosis before plication **(2)** anastomosis after plication

The extent of anastomotic narrowing is sought to set a balanced flow in the distal arteries sufficient to regain the distal pulsation over the wrist arteries and at the same time maintains flow in the vein adequate for a good function of the fistula.

The success of the procedure was achieved when the patient had measurable reduction and augmentation across the fistula and in the distal arteries, respectively.

The outcome was clinically evaluated (patients' symptoms, pulse, capillary refill, warmth and quality of thrill over the vein)for all

cases immediately post-operative. Follow up was done at 1, 3, 6, 12, and 18 months later by clinical as well as duplex examinations.

At follow up, clinical success was defined by presence of adequate distal pulses, improvement of patient symptoms and healing of tissues' trophic changes.

RESULTS

This study included 21 patients presented to the vascular surgery department in Cairo university teaching hospitals having dialysis shunt-associated steal syndrome with autogenous brachial artery based accesses fulfilling our inclusion/exclusion criteria, between May 2015 and October 2016.

The patients were into two groups; group (1) included nine patients treated with DRILL procedure while group (2); for twelve patients treated with plication of fistula's anastomosis.

The patient's age varied between 25 and 70 years with a mean of 61.8 they included 11 males (52.38%). Seven (33.33%) patients were diabetics, 5 (23.8%) had hypertension, 3 (14.3%) had chronic liver disease and 3 (14.3%) patients had peripheral arterial occlusive disease but not involving the limb in question**. (table 1)**

Table (1); Patients demographics:

Patients demographics		
Sex	M: F	11 : 10
Mean age	61.81	
Co-morbidity		
Diabetes Mellitus	7	33.33%
Hypertension	5	23.8%
Chronic liver disease	3	14.3%
PAOD	3	14.3%

Duplex prior to the procedure detected retrograde flow in brachial artery distal to anastomosis in all patients with sufficient arterial function (adequate biphasic or triphasic flow pattern, norelevant arterial obstruction, patent both radial and ulnar arteries).

Brachio-cephalic was the predominant type in both groups **(table 2)** so as the tissue loss and gangrene were the most common clinical presentations among both groups **(table 3)**.

Table (2): types of fistulae

Type of fistulae	**Group 1**	**Group 2**	**P value**
Brachio cephalic	6 (66.67%)	8 (66.66%)	.096972
Brachiobasilica	3 (33.33%)	4 (33.33%)	

Table (3): clinical presentation

Presentation	**Group 1**	**Group 2**	**P value**
Rest pain	3 (33.33%)	5 (41.66%)	.697161
Gangrene	6 (66.66%)	7 (58.33%)	

There was no statistically significant difference between the two groups regarding the demographic data, the type of fistula and the clinical presentation.

Regarding operative criteria, (group 1)patients were admitted as an inpatient; all cases were done under general anesthesia with longer operative duration, whereas(group 2)patients were admitted as an outpatient, the procedure was performed mostly under local anesthesia, with a short operative duration.

In case of fistula plication, the blood flow was put down byapproximately 50% of theinitially measured flow (the mean blood flow preoperative was 2091.66 ml/min reduced to 1000 ml/min after surgery).

In case of DRILL, the peak systolic velocity at the wrist was increased approximately three times to the initially measured velocity (the preoperative peak systolic velocity was 11ml/s that increased to 34.4ml/s after surgery).

Of the 9 patients included in (group 1) one patient had wound infection which mandated shunt closure two weeks postoperative, another 2 patients had complications (seroma and infection)in the wound of the saphenous vein harvest. They were that treated medically.**(Table 4)**

Table 4: operative criteria

Operative criteria	Group 1	Group 2	P value
Type of admission	Inpatient	Day case	
Type of anaethesia • Local anaethesia • Local anaethesia&Sedation • Generalanaethesia	 9 (100%)	 6 (50%) 3 (25%) 3 (25%)	.002722
Complications: • Wound infection • Saphenous wound complications:(seromaand infection)	 1 (11.11%) 2 (22.22%)	 0 -	 .236724 .086018

Time of follow-up was 18 months. Regarding group 1 in all but 2 cases (shunt had to be closed because of wound infection and puncture-related infection after 1 and 3 months respectively),the fistula could be used for dialysis; in another case thrombectomy was necessary after 12 month for shunt thrombosis.The remaining six patients still undergo hemodialysis via the fistula with normal hand function**(table 5)**.

Regarding group 2 in two patients the fistula plication did not lead to an improvement of the symptoms (after one and three months) and therefore had to undergo second operation, the shunt could be preserved by DRILL operation. Another patient died for cardiac insufficiency after 12 months, with patent fistula. The remaining nine patients still undergo hemodialysis via plicated fistula with normal hand function **(table 5)**.

Table 5: follow up of the patients

Follow up (months)	**Group 1**	**Group 2**	**P value**
0	9 cases were successful	12 cases were successful	1
1	Ligation of one access due to wound infection	Recurrence of steal in one case then treated with DRILL	
3	Ligation of another shunt because of puncture-related infection	Recurrence of steal in another case then treated with DRILL	
6	7 cases had normal hand function, fistula in use	10 cases had normal hand function with fistula in use	.798217
12	In another case revision was necessary for shunt thrombosis.	One patient died from cardiac insufficiency with patent hemodialysis access	
18	6 cases had normal hand function, fistula in use	9 cases had normal hand function with fistula in use	.828812

DISCUSSION

Dialysis-associated steal syndrome (DASS) is a rare with incidence range (1.6% to 8.0%) but important complication with significant impact on limb functionality and viability. [1, 2]

A dialysis access always means a change of the hemodynamic flow of the extremities, which usually doesnot lead to clinical symptoms [18]. Moderate ischemic symptoms can occur but mostly resolve spontaneously within several weeks. Only few patients suffer from minor problems such as intermittent coolness of the hand or weakness after exercise. In rare cases, however, ischemia-associated complications with the need for surgical intervention may develop [19].

Unfortunately DASS cannot be predicted.Neither the patients' medical history nor certain measuring methods or surgical techniques can satisfyingly minimize the risk of development of DASS [9,18,19]. Accesses originating from the brachial artery are the major predisposing factor for ischemia. The absence of collateral vessels around the elbow seems to be one of the reasons [13, 20].

The development of a DASS seems to be multifactorial. Occlusive arterial diseases, stenotic areas, underlying neuropathic diseases, or calcifying sclerosis have been described as risk factors for the development of DASS [3, 13].

Typical severe ischemic pain, either stress-induced or at rest, pallor or discoloration, necrosis, or gangrene are clear signs of DASS [19].

There are some treatment options for DASS including flow-limiting surgical operations such as fistula closure, plication, or narrowing of efferent vein with banding; revascularization operations such as proximalization of arterial inflow (PAI), revision using distal inflow (RUDI), and distal revascularization–interval ligation (DRIL); and endovascular treatment options such as elimination of arterial stenosis by angioplasty; and DRA (distal radial artery) embolization especially in forearm fistulae [16].

Closure of fistula provides a definitive solution for eliminating steal syndrome and improving distal perfusion although it results in the loss of dialysis access, which is vital for a patient, creating a great disadvantage for patients who are dependent on a functioning dialysis access on the long term. It is highly likely that the options for creation of a new AV fistula will be limited, and steal syndrome will recur by creating a new fistula in upper arm. As similar symptoms emerge upon the creation of a new fistula on the contra lateral extremity in many cases, fistula closure should be only used when other surgical or endovascular treatment options fail [16, 21].

According to our results there is no statistically significance difference regarding demographic data and associated comorbidities between the two groups which is comparable to most studies, however, Florian and his colleagues found that diabetes mellitus is an important factor for poor outcome regarding successful intervention in DASS especially in late cases [22].

In our study all cases were originating from brachial artery which coincides with literature that accesses originating from the brachial artery are a major predisposing factor for ischemia [22].

Table 6: Therapeutic concepts(literatures)

Author	Number of patients	Therapy	Therapy-control	Follow-up
Aschwanden et al. [23]	3	Banding	Indirect Duplex/Doppler ultrasound comparison of right/left subclavian blood flow	Normal function, HA in use
Valji et al. [19]	7	Angioplasty	Clinical surveillance	n.d.
White et al. [3]	1	Banding	Duplex/Doppler	Normal function, HA in use
Morsy et al. [24]	12	Banding (n=6) Closure (n=4) Embolization (n=1) DRIL (n=1)	n.d – n.d. n.d.	n.d. – n.d. n.d
Odland et al.[25]	25	Closure (n=9) Banding (n=16)	– Digital photoplethysmography	– Normal function in 25 cases; in ten cases, HA in use
Korzets et al.[26]	9	DRIL	Clinical surveillance	Normal function in eight cases; in seven cases, HA in use
Jean-Baptiste and Gahtan [27]	1	DRIL	Clinical surveillance	n.d.
Henriksson and Bergqvist [5]	2	Interposition of PTFE loop	Clinical surveillance	Normal function, HA in use
Goel et al. [28]	16	Banding	Clinical surveillance	Normal function, HA in use
Florian et al [22]	15	Banding	Intraoperative: Blood flow control; postoperative: Duplex/Doppler,clinical surveillance	Normal function in ten cases, need for further intervention in five cases
Own study	21	DRIL(n=9) Plication(n=12)	Clinical surveillance;postoperative Duplex Clinical surveillance;postoperative Duplex	Normal function in 9cases&in 6 cases HA in use Normal function in 12 cases&in9 cases HA in use

n.d.no data, DRIL distal revascularization interval ligature, PTFE polytetrafluoroethylene, HA hemodialysis access

The procedures are mostly chosen individually and results are discussed controversially **(Table 6)**. Although flow-limiting surgical operations such as plication or narrowing of efferent vein with banding arean easy ways of treating DASS, there are only fewreports on the success of this technique. One reason is the inherent problem of balancing fistula flow with distal flow [28], however this problem can be avoided in plication by the number of interrupted sutures taken at the toe of the anastomosis.

Although DRILL is considered the standard procedure in treating DASS but it carries inherent problems regarding the complexity of the procedure being considered as mini bypass, lengthy operation and should be done under general anesthesia in addition to the burden of the saphenous vein harvesting. However fistula plication is a simple procedure which can be done under local anesthesia (75% of our patients) with a short operative time.

Fistula plication had comparable results regarding the patency rate to the DRILL, in two patients fistula plication did not lead to an improvement of the symptoms (after one and three months)and therefore had to undergo second operation, the shunt could be preserved by DRILL.

An interesting aspect in fistula plication, it can be done safely during conduction of the access if there is a manifestation of hand ischemia with absent distal pulsations.

CONCLUSION

DASS is a rare but important complication of HA and mostly occurs in brachial HA. DASS cannot be predicted. The cause of DASS is multifactorial. Because of that there are different forms and characteristics of DASS with different ways of treatment. We evaluated the plication technique in treatment of DASS that we have established in our institution. We found that HA plication under blood flow control as easily performable procedure is an adequate therapeutic option in patients with DASS

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