

Treatment of steal syndrome in patients with arteriovenous fistula: Narrowing the arterial part of anastomosis

Arteriyovenöz fistüllü hastalarda çalma sendromunun tedavisi: Anastomozun arteriyel kısmının daraltılması

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ABSTRACT

If primary vascular access fails, secondary and tertiary vascular accesses in the proximal sides are needed in patients undergoing hemodialysis due to end-stage renal disease. Unfortunately, the risk of steal syndrome is higher, if the vascular access is created in the proximal sides. Although steal syndrome is rare, it is a potentially devastating complication. Herein, we present two cases of steal syndrome which was treated by narrowing the arterial part of the anastomosis. With the anastomotic narrowing technique which we used, ischemic symptoms of the first case regressed completely, and wound healing was achieved after some time. Ischemic symptoms of the second case also regressed completely with pain relief. Arteriovenous fistulas (AVFs) of both cases were preserved, and the patients underwent hemodialysis through the AVFs for 40 and 21 months, respectively. We believe that narrowing the arterial part of the anastomosis under the intraoperative color Doppler ultrasonography guidance is a simple technique which does not require the use of any foreign materials, and it may be effective in patients with steal syndrome due to a high-flow rate and a large anastomosis, not due to peripheral arterial disease.

Keywords: Arteriovenous fistula; complications; hemofiltration.

ÖZ

Son dönem böbrek yetmezliği nedeniyle hemodiyalize giren hastalarda birincil vasküler erişim sağlanamadığında, proksimal seviyelerden ikincil ve üçüncül vasküler erişime gereksinim duyulur. Ne yazık ki, vasküler erişim proksimal seviyelerden sağlandığında, çalma sendromu gelişme riski daha yüksektir. Çalma sendromu nadir görülmekle birlikte, büyük olasılıkla zarar verici bir komplikasyondur. Bu yazıda, anastomozun arteriyel kısmının daraltılması ile tedavi edilen çalma sendromlu iki olgu sunuldu. Kullandığımız anastomoz daraltma tekniği ile birinci olgunun iskemik semptomları tamamen geriledi ve bir süre sonra yara iyileşmesinin olduğu gözlemlendi. İkinci olgunun iskemik semptomları da tamamen geriledi ve ağrı kayboldu. Her iki olgunun da arteriyovenöz fistülleri (AVF) korundu ve hastalar sırasıyla 40 ve 21 hafta süre ile bu AVF'ler ile hemodiyalize girdi. Ameliyat sırası renkli Doppler ultrasonografi eşliğinde anastomozun arteriyel kısmının daraltılmasının herhangi bir yabancı materyal kullanımı gerektirmeyen basit bir teknik olduğu ve periferik arter hastalığına bağlı değil, fakat yüksek akım hızı ve geniş anastomoz nedeniyle çalma sendromlu hastalarda etkili olduğu kanaatindeyiz.

Anahtar sözcükler: Arteriyovenöz fistül; komplikasyonlar; hemofiltrasyon.

Radiocephalic arteriovenous fistula (AVF) was first described by Brescia-Cimino-Appel in 1966.^[1] One of the reasons to use this AVF for hemodialysis is its low complication rates.^[2] If primary vascular access fails in patients undergoing hemodialysis due to of end-stage renal disease (ESRD), secondary and

tertiary vascular accesses in the proximal sides are needed. Unfortunately, the risk of steal syndrome is higher in the vascular accesses created in the proximal sides.^[3] Although steal syndrome rarely develops, it is a potentially devastating complication of angioaccess surgery. In the literature, several effective

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and complicated methods have been proposed in the treatment of steal syndrome.

Herein, we present two cases in whom steal syndrome developed which was treated by narrowing the arterial part of the anastomosis under the intraoperative color Doppler ultrasonography (USG) guidance.

CASE REPORT

Case 1- A 60-year-old female patient who was on insulin treatment due to diabetes mellitus (DM) was on hemodialysis for eight years. Previously, she had radiocephalic (wrist) and antecubital (elbow) AVF operations in her both arms. At the time of admission to the outpatient clinic, she was on hemodialysis three times a week through a permanent catheter which was inserted in the right jugular vein. The patient underwent left brachio-basilic vein transposition arteriovenous fistula (BBAVF) operation. After two months, a wound occurred at the distal side of the third finger due to steal syndrome, which was not healing. She also developed Stage IV limb ischemia (Figure 1). The patient's left arm's Digital Brachial Index (DBI) was measured as 0.42. The fingertip oxygen saturation was 78%. The AVF flow was measured as 1600 mL/min. A banding operation with a polytetrafluoroethylene (PTFE) graft was performed 2 cm proximal to the AVF to treat steal syndrome. Postoperative AVF flow rate was measured as 425 mL/min. Eight days later, the patient was re-admitted in the outpatient clinic due to AVF thrombosis and underwent surgery urgently. The PTFE banding on the basilic vein was removed



Figure 1. The wound which was not healed for about one month on the distal side of the third finger of the left hand.

and basilic vein thrombectomy was performed. The AVF flow was re-achieved. Then, direct narrowing of the arterial part of the anastomosis was performed under Doppler USG guidance. Step by step the fistula flow was measured, and the operation stopped after reducing the fistula flow to 650 mL/min. The DBI was measured as 0.92, and the capillary refill time was 2 to 4 sec, postoperatively. The fingertip oxygen saturation was 94%, and distal pulses were palpable. The wound on her finger and pain improved during follow-up visits.

Case 2- A 72-year-old female patient with DM underwent a left-arm BBAVF operation about two years ago. She was on hemodialysis three times a week for two years. Previously, the patient was suffering from chills and coldness in her left hand and pain in her left forearm during hemodialysis. Later, changes appeared in the nailbed and in the dorsum of her hand due to ischemia. The patient had rest pain (Stage III), when she was admitted to our outpatient clinic. Left-hand radial and ulnar pulses were non-palpable. The DBI was measured as 0.44, and the fingertip oxygen saturation was 84%. Preoperative AVF flow was measured as 1,400 mL/min with Doppler USG. The patient underwent surgery. The arteriovenous anastomosis was explored. The AVF was gradually narrowed was performed by the direct narrowing of the arterial part of the anastomosis under intraoperative Doppler USG-guidance, measuring the flow in the subclavian vein. Subclavian vein flow was reduced to 700 mL/sec during surgery. Left arm DBI was 0.88, and the capillary refill time was 3 to 5 sec

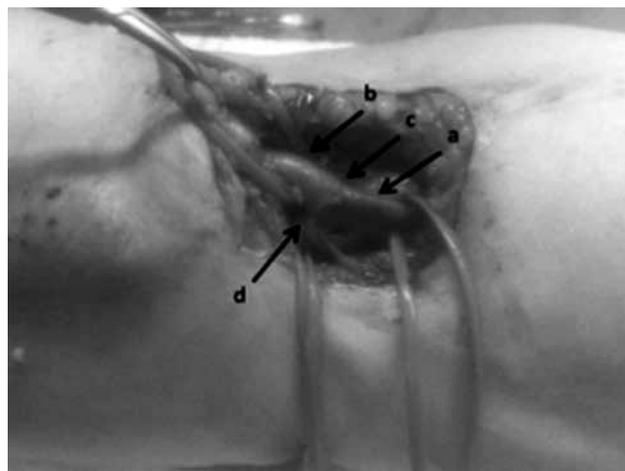


Figure 2. Exposure of brachio-basilic arteriovenous fistula. a: distal of brachial artery; b: Basilic vein; c: Anastomosis line; d: Proximal of brachial artery.

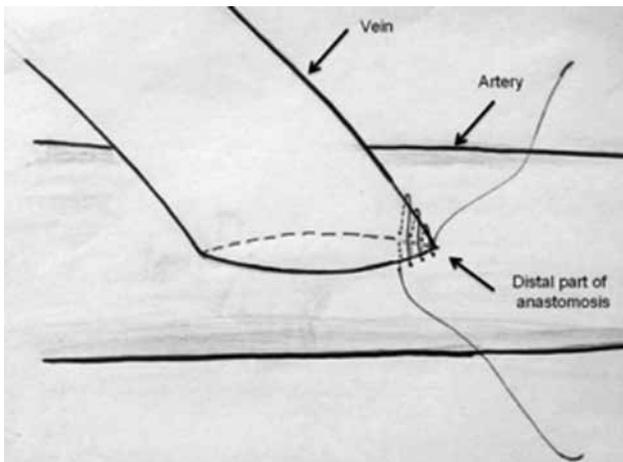


Figure 3. Suturing starting from the distal arterial end of the arteriovenous fistula toward the proximal side.

postoperatively. The fingertip saturation oxygen was 95%, and the radial and ulnar pulses were palpable (Table 1). During follow-up, ischemic pain improved.

The procedure was performed under local anesthesia. Fingertip saturation oxygen was measured intraoperatively, and the radial artery cannulated. The vein and artery of the fistula were dissected free at a length of 0.5 to 1 cm near the arteriovenous anastomosis in the ischemic hand of the patient.

The arterial side of the anastomosis was dissected clearly (Figure 2). Then, the surface of the arteriovenous anastomosis was cleaned carefully. Starting from the distal end, the arterial sides of the anastomosis were sutured with 6/0 prolene using continuous sutures (Figure 3). In addition, a half-moon shaped suture was passed through the artery, including the venous side of the AVF (Figure 4). The flow of the subclavian vein was simultaneously measured with Doppler USG intraoperatively. The flow of AVF was evaluated by this way. If the flow rate of the AVF was too low, the last suture was removed. In this way, a sufficient flow rate was attempted to be provided in the AVF. Radial artery monitoring and fingertip oxygen saturation were assessed intraoperatively, when adequate flow rate of AVF was achieved. Once appropriate flow rate in the AVF was maintained, surgery was completed closing the subcutaneous tissues and skin.

DISCUSSION

Although steal syndrome in upper extremity is rare in patients under hemodialysis due to ESRD, it

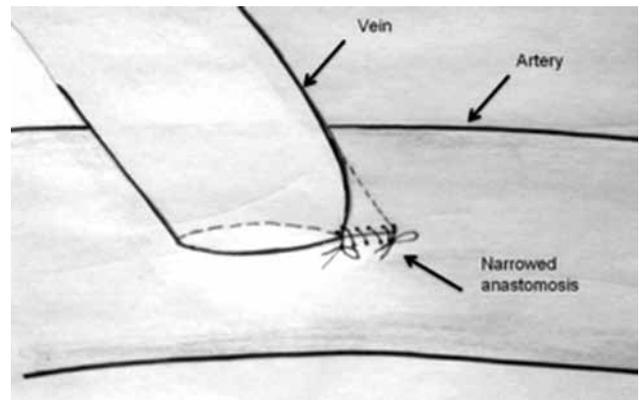


Figure 4. Narrowed anastomosis.

is an important condition. Although these patients do not have any peripheral arterial disease, severe critical hand ischemia may develop in these patients. Various clinical factors such as age, female sex, DM, peripheral arterial occlusive disease, brachial-artery access, previous episodes of steal syndrome, large conduits, and multiple prior access procedures have been identified as predictors.^[3,4] Of note, AVF-dependent steal syndrome is supposed to be due to wide anastomosis and high flow in absence of peripheral arterial occlusive disease.^[2]

The rate of upper extremity steal syndrome has been reported as 3.7 to 5% in dialysis patients.^[3] This rate also varies depending on the type of the AVF. Although the rate of steal syndrome in radiocephalic AVF has been reported as 1.8%, this rate increases to 10 to 25% in brachiocephalic AVF or BBAVF.^[3,5] Ischemic symptoms due to upper extremity steal syndrome are usually in a form of coldness, pain, cramps, reduced sensibility, and strength loss. It can be easily diagnosed on physical examination.

The four steps of limb ischemia may be observed:^[2]

- Stage I: pale/blue and/or cold hand without pain
- Stage II: pain during exercise and/or hemodialysis
- Stage III: rest pain
- Stage IV: ulcers/necrosis/gangrene

When complaints and physical examination of the patient are suggestive of steal syndrome, additional findings such as transcutaneous PO₂ measurement (pulse oximetry), plethysmography, digital pressure <50 mmHg, a digit/brachial index (DBI) <0.6, and TCPO₂ <20 to 30 mmHg may support the diagnosis.^[2,6-8] Neuropathy (carpal tunnel syndrome),

dystrophy, and edema due to venous hypertension, arteriosclerotic disease, secondary hyperparathyroidism or DM may exaggerate or mimic the symptomatology of steal syndrome. The diagnosis of steal syndrome is typically based on the clinical history and physical examination, which is supported with imaging studies.

There are many treatment options for patients with steal syndrome. The treatment goals for patients with steal syndrome are to reverse the hand ischemia and to salvage the access. The treatment options include simple ligation or takedown of the fistula, correction of arterial inflow stenosis/occlusion, flow limiting procedures (banding or tapering of AVF, inflow reduction, anastomotic narrowing, and outflow reduction), distal revascularization-interval ligation (DRIL), proximalization of the arterial inflow (PAI), revision using distal inflow (RUDI), and proximal radial artery ligation (PRAL).^[9]

Ligation or takedown of fistula is the simplest form of treatment. In patients with DM, ischemia increases the risk of finger amputation. In such patients, this technique invariably eliminates ischemia.^[10] However, a new AVF is required in another area. However, both patient and surgeon may avoid from this idea due to the risk of developing ischemia at this new AVF.

A stenosis in the inflow artery proximal to the arteriovenous access may contribute to the development of steal syndrome. The use of color Doppler USG, which is a non-invasive method, may help us for perioperative assessment. The criteria for appropriate inflow artery have been proposed greater than 3 mm for brachial artery and greater than 2 mm for radial artery.^[9] Arteriography may be used for the diagnosis and treatment in patients with significant stenosis, as assessed by Doppler USG.

Various flow-limiting procedures have been proposed for the treatment of steal syndrome. These procedures are inflow reduction, anastomotic narrowing, and outflow reduction. Banding technique was first reported in 1975 by Anderson and Groce^[11] in three patients who were operated due to cardiac overload. The main problem of this technique is to provide the patency of AVF, while providing the adequate distal perfusion. In addition, over time, the biological behavior and hemodynamics of the AVF may change (e.g. inflow artery dilation, outflow vein dilatation) after the intervention.^[9] Gupta et al.^[12] performed banding operation in 22 one of 114 cases who had surgery due to steal syndrome. In the

forementioned study, AVF thrombosis was observed in 19% of the patients who underwent banding operation, and steal syndrome-related symptoms persisted in 48% of them. Ozbek et al.^[13] also reported successful results with banding method by monitoring the pressure from the radial artery to reduce the risk of thrombosis and to ensure adequate fistula flow. However, when the blood flow is reduced enough to fix the steal syndrome with the banding method, thrombosis of the access is so common that it cannot be ignored. In addition, Miller et al.^[14] reported successful treatment series with a minimally invasive variant, called Miller banding procedure (minimally invasive limited ligation endoluminal-assisted revision) and found that the six-month patency rate was 75%. Zanow et al.^[15] also performed flow reduction surgery using intraoperative flow monitoring in 95 patients with ischemia and heart failure due to a high-flow arteriovenous access. Seventy-seven of these patients underwent reduction surgery of autogenous AVF. The authors narrowed the fistula vein near the anastomosis for a distance of 2 to 3 cm with spindle-like, continuous polypropylene 6-0 sutures. When the desired access flow was attained, a PTFE strip was placed and sutured around the narrowed segment of the autogenous access. The authors reported that ischemic symptoms completely regressed in 86% of 77 patients who underwent surgery due to ischemia, and there was slight or moderate pain during dialysis in 14% of them at four weeks. The authors had to use a PTFE to narrow vein side of the anastomosis. In our patients, we directly narrowed the arterial side of the anastomosis, and there was no need to use any foreign materials.

The DRIL procedure was first described by Schanzer et al.^[16] In elbow AVFs, the blood flow to the brachial artery is above the arteriovenous anastomosis to the radial or ulnar artery. In addition, interval ligation of the artery is between arteriovenous access and distal anastomosis of the bypass. It has been reported that ischemic symptoms disappear and the AVF is protected in 83 to 100% of patients with DRIL procedure.^[17] However, this technique has raised a number of concerns claiming that hand perfusion is dependent on the patency of the graft used. On the other hand, the results are satisfactory.

The PAI procedure was first described in 2006 by Zanow et al.^[18] This procedure is proposed for the group of patients with severe hand ischemia due to AVF, or those whose blood flow was under

800 mL/min in their native fistulas or under 1000 mL/min in the graft. Using this technique, re-siting access anastomosis is done more proximal on the arterial tree (e.g. re-siting from the brachial artery from antecubital to brachial artery near the axilla). By this way, perfusion to the hand may be improved. Zanow et al.^[18] concluded that this technique could be a good alternative to the DRIL procedure, particularly in vascular accesses with low flow. However, to move an autogenous access to the proximal side with a composite prosthetic/autogenous graft increases the risk of infection and thrombosis.^[9]

The RUDI technique is the opposite of PAI, and it is about re-siting the arteriovenous anastomosis further distal on the arterial tree by disconnecting the original anastomosis, and interposing a saphenous vein bypass.^[19] Basically, it changes a brachial artery-based access into a radial artery access. The main problem of the radial artery is its smaller calibration and higher prevalence of the occlusive diseases in the forearm vessels. This may limit the ability of the arterial inflow to vasodilate and increase flow in response to the access.^[9]

The PRAL technique was first described by Bourguelot et al.^[20] for the treatment of steal syndrome which occurred in the forearm fistulas. The juxta-anastomosis proximal to radial artery was freed and divided. Primary patency rates at one and two years were 88±6% and 74±9%, respectively.

Using our anastomotic narrowing technique, ischemic symptoms of our first patient regressed completely, and wound healing was observed after some time. Ischemic symptoms of our second case completely regressed and pain was lost. In addition, AVFs were protected in both patients, and they underwent hemodialysis through those AVFs for 34 and 26 months, respectively.

In conclusion, we believe that narrowing the arterial part of the anastomosis under the intraoperative color Doppler USG guidance is a simple technique which does not require the use of any foreign materials, and it may be effective in patients with steal syndrome due to a high-flow rate and a large anastomosis, not due to peripheral arterial disease.

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