Treatment of Steal Syndrome in Patients With Arteriovenous Fistula: "Narrowing the Arterial part of the Anastomosis" Case Report

Arteriovenöz Fistülü Olan Hastalarda Steal Sendromunun Tedavisi: Anastomozon Arteryel Parçasının Daraltılması

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ABSTRACT If primary vascular access fails, secondary and tertiary vascular accesses in proximal sides are needed in patients who have hemodialysis due to end-stage renal disease. Unfortunately the risk of steal syndrome is higher if the vascular accesses is created in the proximal sides. Steal syndrome develops rarely, but it is a potentially devastating complication. In this study, we aimed to present two patients who were treated by narrowing the arterial part of the anastomosis. With the anastomotic narrowing technique that we used, the ischemic symptoms of the first patient regressed completely, and wound healing was observed after some time. The ischemic symptoms of our second patient regressed completely, and pain was lost. Both the patients' arteriovenous fistulas (AVF) were protected, and they had hemodialysis through those AVFs for 40 and 21 months, respectively. We suppose that the narrowing arterial part of the anastomosis under intraoperative color Doppler ultrasound guidance is a simple technique not requiring use of any foreign materials, and it may be effective in the patients with steal syndrome occurring due to a high flow rate and a large anastomosis, not due to peripheral arterial disease.

Key Words: Arteriovenous fistula; hemofiltration; complications

ÖZET Son dönem böbrek yetmezliği nedeniyle hemodiyaliz tedavisi alan hastalarda primer arteriovenöz (A-V) fistül durduğunda, daha proksimal seviyelerden sekonder ve tersiyer A-V fistül açılması gerekli olabilir. Ne yazık ki proksimal seviyelerde açılan A-V fistüllerde steal sendromu gelişme riski daha yüksektir. Steal sendromu nadir gelişen ve zarar verici bir komplikasyondur. Biz bu çalışmamızda anastamozun arteriyel kısmının daraltılması metoduyla tedavi edilen iki hasta sunmayı amaçladık. Bizim yaptığımız anastamoz daraltma tekniği ile birinci hastanın iskemik semptomları tamamen gerilerken, bir süre sonra yara iyileşmesinin olduğu gözlendi. İkinci hastamızın iskemik semptomları tamamen geriledi ve ağrı şikayeti kayboldu. Her iki hastanın da mevcut A-V fistülleri korundu ve hastalar sırasıyla 40 ve 21 hafta süre ile bu A-V fistüllerle hemodiyaliz tedavisi almayı sürdürdüler. İntraoperatif basit ve yabancı madde içermeyen bir yöntem olan Doppler ultrasonografi eşliğinde anastamozun arteriyel kısmının daraltılması tekniğinin periferik arter hastalığı olmayan, yüksek volüm ve geniş anastamoza bağlı gelişen steal sendromlu hastalarda etkili olabileceğini düşünmekteyiz.

Anahtar Kelimeler: Arteriovenöz fistül; hemofiltrasyon; komplikasyonlar

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Radio-cephalic arteriovenous fistula (AVF) was first described by Brescia-Cimino-Appel in 1966.[1] One of the reasons to prefer this AVF for hemodialysis its low complication rate.[2] If primary vascular access fails in patients who have hemodialysis due to of end-stage renal disease (ESRD), secondary and tertiary vascular accesses in proximal sides are needed. Unfortunately, the risk of developing steal syndrome is higher

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in the vascular accesses created in the proximal sides.[3] Steal syndrome develops rarely, but it is a potentially devastating complication of angioaccess surgery. Several effective and complicated methods have been published in the literature in treatment of steal syndrome.

In this study, we aimed to present two patients who were treated by narrowing the arterial part of the anastomosis under intraoperative color Doppler ultrasound-guidance.

CASES

CASE 1

A 60 year-old female patient who was on insulin treatment due to diabetes mellitus (DM) had been on hemodialysis for eight years. Previously, she had radio-cephalic (wrist) and antecubital (elbow) AVF operations in her both arms. At the time of her admittance to outpatient clinic, she had been having hemodialysis three times a week from a permanent catheter that was inserted in her right jugular vein. The patient underwent left brachiobasilic vein transposition arteriovenous fistula (BBAVF) operation. After about two months, a wound occurred at the distal side of her third finger due to steal syndrome, and it was not healing. She developed stage 4 limb ischemia (Figure 1). The patient's left arm's digital brachial index (DBI) was 0.42. The fingertip oxygen saturation was 78%. AVF flow was measured as 1600 ml/min. A banding operation with a PTFE graft was performed 2 cm proximal to the AVF to treat steal syndrome. Postoperative AVF flow rate was measured 425ml/min. Eight days later, the patient was examined in the outpatient clinic again due to AVF thrombosis, and underwent surgery urgently. PTFE banding on the basilic vein was removed, and basilic vein thrombectomy was performed. AVF the flow was achieved again. Then, direct narrowing of the arterial part of the anastomosis was performed under Doppler ultrasonography (USG) guidance. Step by step the fistula flow was measured, and the operation stopped after reducing the fistula flow to 650 ml/min. Digitobrachial index (DBI) was 0.92, and the capillary refill time was 2-4 sec postoperatively. The fingertip oxygen saturation was 94%, and distal pulses were palpable. The wound on her finger and pain seemed improved on follow up visits.

FIGURE 1: The wound that had not healed since approximately 1 month, on distal side of the third finger on the left hand.

CASE 2

A 72-year-old female patient with DM, underwent a left-arm BBAVF operation about 2 years ago. The patient had been on hemodialysis three times a week, for 2 years. Previously, the patient had been complaining of chills and coldness in her left hand, and pain in her left forearm during hemodialysis. Later, changes occurred in her nailbed, and changes seen in the dorsum of her hand due to ischemia. The patient had rest pain when she admitted to our outpatient clinic (Stage 3). Left-hand radial and ulnar pulses were nonpalpable. DBI was measured as 0.44, and the fingertip oxygen saturation was 84%. Preoperative AVF flow was measured as 1400ml/min with Doppler USG. The patient ad 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 subclavien vein. Subclavien vein flow was reduced to 700 ml/sec intraoperatively. it Left arm DBI was 0.88, the capillary refill time was 3-5 sec postoperatively. The fingertip saturation oxygen was 95%, and the radial and ulnar pulses were palpable. (Table 1). On follow-up, ischemic pain improved.

SURGICAL TECHNIQUE

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 arterovenous anatomosis 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 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 tried to be provided in the AVF. Radial artery monitoring and fingertip oxygen saturation were assessed intraoperatively when adequate flow rate of AVF was achieved. Surgery terminated with closing the subcutaneous tissues and skin after providing appropriate flow rate in the AVF.

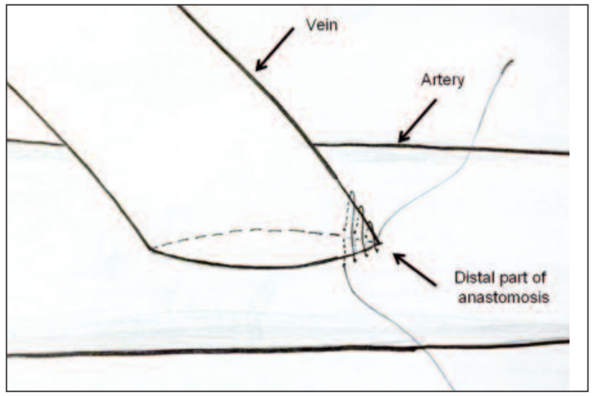

FIGURE 3: Suturing started from the distal arterial end of the arteriovenous fistula towards the proximal side.

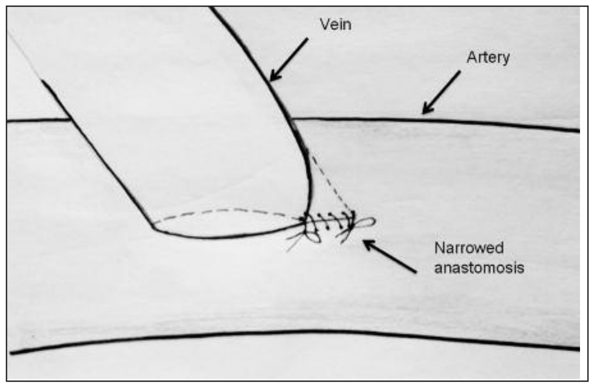

FIGURE 4: Narrowed anastomosis.

DISCUSSION

Although steal syndrome in upper extremity is observed rarely in patients under hemodialysis due to ESRD, it is an important situation. Although those patients do not have any peripheral arterial disease, severe critical hand ischemia may be observed in these patients., Various clinical factors such as age, female gender, DM, peripheral arterial occlusive disease (PAD), brachial-artery based access, previous episodes of steal syndrome, large conduits, and multiple prior access procedures have been identified as predictor in terms.[3,4] AVF-depended steal syndrome is supposed to be due to wide anastomosis and high flow in absence of PAD.[2]

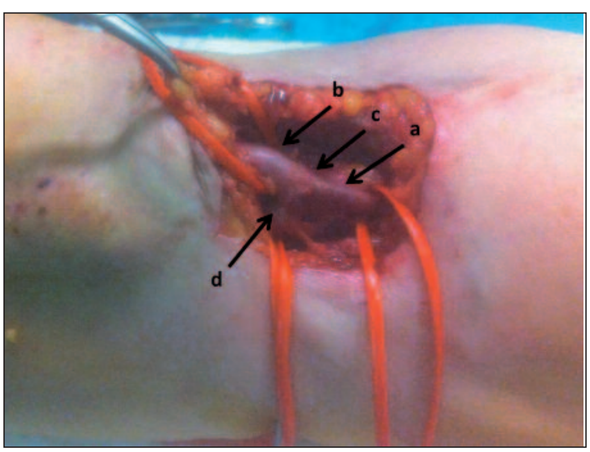

FIGURE 2: Exposure of brachio-basilic arteriovenous fistula. **a)** distal of brachial artery, **b)** basilic vein, **c)** anastomosis line, **d)** proximal of brachial artery.

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

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

Stage 1: pale/blue and/or cold hand without pain

Stage 2: pain during exercise and/or hemodialysis

Stage 3: rest pain

Stage 4: ulcers/necrosis/gangrene

When complaints and physical examination of the patient are suggestive of steal syndrome, additional findings such as tanscutaneous PO2 measurement (pulse oximetry), plethysmography, digital pressure <50 mmHg, a digit/brachial index (DBI) <0.6, and TCPO2 <20-30 mmHg may support the diagnosis Neuropathy (carpal tunnel syndrome), dystrophy and edema due to venous hypertension, arteriosclerotic disease, secondary hyperparathyroidism or DM may exaggerate or mimic the symptomatology of the steal syndrome.[2,6-8] The diagnosis of steal syndrome is based on the clinical history and physical examination, and supported with imaging.

After diagnosis, there are a variety of different treatment options for patients with steal syndrome. The treatment goals for patients with steal syndrome are to reverse the hand ischemia and salvage the access. The treatment options of steal syndrome 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 those patients, this technique invariably eliminates ischemia.[10] However a new AVF is required in another area. However, the risk of developing ischemia at this new AVF gets the patient and the surgeon away from this idea.

A stenosis in the inflow artery proximal to the arteriovenous access may contribute to the development of steal syndrome. 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 diagnosis and treatment in the patients that significant stenosis is determined with Doppler USG.

Various flow-limiting procedures have been proposed for treatment of steal syndrome. These procedures are inflow reduction, anastomotic narrowing and outflow reduction. Banding technique has been first reported in three patients that had surgery due to cardiac overload in 1975, by Anderson.[11] The main problem in this technique is to provide the patency of AVF while providing the adequate distal perfusion. In addition, in course of time, after the intervention, the biological behavior and hemodynamics of the AVF may change (eg. inflow artery dilation, outflow vein dilatation).[9] Gupta et al. performed banding operation in 22 one of 114 cases that had surgery due to steal syndrome. In the same study, AVF thrombosis was observed in 19% of the patients who underwent banding operation, and steal syndrome-related symptoms persisted in 48% of them.[12] Ozbek et al. 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.[13] 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 can not be ignored. In addition, Miller et al. reported successful treatment series with a minimally invasive variant, called Miller banding procedure (Minimally Invasive Limited Ligation Endoluminal-Assisted Revision), and they reported six-month patency rate as 75%.[14] Zanow et al. performed flow reduction surgery using intraoperative flow monitoring in 95 patients that had ischemia and heart failure due to a high-flow arteriovenous access.[15] Seventy seven of those patients underwent reduction surgery of autogenous AVF. Zanow narrowed the fistula 'vein' near the anastomosis for a distance of 2 to 3 cm with spindle-like, continuous palypropylene 6-0 sutures. When the desired access flow was attained, a polytetrafluoroethylene (PTFE) strip was placed and sutured around the narrowed segment of the autogenous access. Zanow reported that ischemic symptoms completely regressed in 86% of 77 patients that had surgery due to ischemia, the and there was slight or moderate pain during dialysis in 14% of them after 4 weeks. The author had to use PTFE to narrow vein side of the anastomosis. In our patients, we *narrowed directly the arterial side of the anastomosis*, there was no need to use any foreign materials.

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

PAI procedure was first described in 2006 by Zanow et al. This procedure is proposed for the group of patients that had severe hand ischemia due to AVF, or the patients whose blood flow was under 800 ml/min in their native fistulas or under 1000 ml/min in the graft.[18] In this technique, resiting the access anastomosis is done more proximal on the arterial tree (eg, re-siting from brachial artery from antecubital to brachial artery near the axilla). With this way, perfusion to the hand may be improved. Zanow et al. concluded that this technique may be a good alternative to the DRIL procedure, especially in vascular accesses with low flow.[18] However, to move an autogenous access to the proximal side with a composite prosthetic/autogenous graft increases the risk of infection and thrombosis.[9]

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 redial artery access. The main problem of 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]

PRAL technique has been described by Bourguelot et al. to treat steal syndrome that occur in forearm fistulas.[20] The juxta-anastomosis proximal to radial artery is freed and divided. Primer patency rates reported at 1 and 2 years were 88±6% and 74 ±9%, respectively.

With our anastomotic narrowing technique, the ischemic symptoms of our first patient regressed completely, and wound healing was observed after some time. The ischemic symptoms of our second patient completely regressed and pain was lost. AVFs were protected in both patients, and they had hemodialysis through those AVFs for 34 and 26 months, respectively.

CONCLUSION

We suppose that the narrowing the arterial part of the anastomosis under intraoperative color Doppler ultrasound-guidance is a simple method, and does not require any foreign materials. It may be effective in the patients that have steal syndrome due to a high flow rate and a large anastomosis, not due to peripheral artery disease.

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