ELSEVIER

General Review

Perigraft Seroma after Extra-anatomic Bypass: Case Series and Review of the Literature

Daniele Bissacco,[1,2] Maurizio Domanin,[1,2] Silvia Romagnoli,[1] and Livio Gabrielli,[1,2] Milan, Italy

Background: Extra-anatomic bypass (EAB) remains a viable alternative for lower limb revascularization if aorto-bifemoral bypass and endovascular therapy are contraindicated. Among EAB, periprosthetic seroma (PS) occurs in about 4% of cases. Diagnostic and therapeutic management, as well as standardized treatment paradigm, are still not well defined. The aim of this study is to report 5 PS cases in EAB and to review literature about similar cases.

Methods: We retrospectively reviewed EAB performed during the period 2002–2015. Among these, we described PS cases. A similar description for all cases found in the literature through research on the major international databases (PubMed, Scopus, EMBASE) was made.

Results: During the study period, 797 bypasses—528 (66.3%) anatomical and 269 (33.7%) extra-anatomical—were performed. Among the latter, 169 femoro-femoral (FF), 20 axillo-femoral (AXF), 22 axillo-bifemoral (AxBF), and 58 aortouni-iliac endoprosthesis (AUI) + FF bypasses were performed. Five cases (1.86%) of PS in EAB population were detected: 3 after AxBF and 2 after AUI + FF. Although we initially preferred percutaneous drainage, a surgical choice with graft explant and replacement were imposed by the high recurrence rate. Literature analysis identified 19 additional cases (11 after AxBF, 7 after AXF and after AUI + 1 FF).

Conclusions: Our case series and the literature confirm that the most widely used therapy is the surgical drainage with primary or secondary replacement of the graft of a different material. Percutaneous drainage has proved ineffective because not conclusive and potential to increase risk of graft infection. Careful follow-up, even years after surgery, remains necessary for diagnosis of this complication, to document the possible PS and prevent potential infection.

INTRODUCTION

Extra-anatomic bypass (EAB) grafts, that is, axillo-femoral (AxF), axillo-bifemoral (AxBF), or femoro-femoral (FF), are excellent alternatives for revascularization of aorto-iliac occlusive disease in high-risk patients (HRP).[1–3] Moreover, the aortouni-iliac (AUI) repair with FF bypass is the ideal solution in case of endovascular aneurysm repair (EVAR) of an abdominal aortic aneurysm (AAA) with poor iliac axes, showing good long-term patency rates.[4]

However, they can be burdened with several complications that all bypass grafts have in common, such as thrombosis, infections, pseudoaneurysms, and so on. Among these, perigraft seroma (PS) is a peculiar complication of EAB grafts that consists in persistent sterile fluid that collects around the graft with pseudocapsules formation.

The real prevalence of PS is difficult to estimate, considering its sporadic nature and late onset. Its prevalence has been reported between 0.48% and 4.2%.[5–8]

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

[1]Department of Vascular Surgery, IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy.

[2]Università degli Studi di Milano, School of Vascular Surgery, Milan, Italy.

Correspondence to: Daniele Bissacco, MD, Department of Vascular Surgery, IRCCS Ca' Granda Ospedale Maggiore Policlinico, Via Francesco Sforza, 46, Milan, Italy; E-mail: danielebissaccomd@gmail.com

Ann Vasc Surg 2017; ■: 1–8
http://dx.doi.org/10.1016/j.avsg.2017.03.201

Manuscript received: November 3, 2016; manuscript accepted: March 28, 2017; published online: ■ ■ ■

Etiology and natural history of PS have not yet been clearly clarified, nor therapeutic indications. Several hypotheses have been advanced to explain the serum accumulation after vascular graft implants, including both graft- or patient-related factors, although the pathogenesis appears to be multifactorial.

Clinical presentation includes a nonpulsatile, nontender swelling along the course of the bypass. Usually, there is no discomfort at rest, but pain is sometimes caused by palpation or by coughing, particularly when PS occurs after FF bypass. Sometimes a slight erythema of the overlying skin can be observed.[9,10] Because this collection is asymptomatic in most cases and the graft remains patent, the patient usually shows up when the PS has achieved relevant dimensions, feeling anxious and afraid about progressive growth of the mass along the graft in a subcutaneous location.

Diagnosis is primarily clinical: patient's history together with physical examination is mandatory to steer the surgeon in diagnostic and therapeutic choices. The time interval of PS development and the presence of fever or other systemic symptoms must be always investigated. Blood tests including complete blood count, coagulation, C-reactive protein, and erythrocyte sedimentation rate are required to exclude infection.

Doppler ultrasound (DUS) is the first choice instrumental investigation to evaluate graft patency and PS size. Computed tomographic angiography (CTA) should be considered only as a second-level test to assess PS extension and to exclude anastomotic pseudoaneurysms.

As for the previous issues, ideal treatment has not yet been defined and indications range from *watchful waiting* approach to complete removal of EAB graft and its substitution with a graft of different material. We present a case series of PS after AxBF bypass and AUI endograft + FF crossover bypasses, together with a literature review of similar cases, to define clinical presentation, therapeutic decision making, and outcomes of this unusual but potentially serious complication.

CASE SERIES

Case 1

A 75-year-old woman with a history of chronic obstructive pulmonary disease, hypertension, and myocardial infarction underwent polytetrafluoroethylene (PTFE) AxBF bypass graft due to an aorto-bifemoral bypass graft thrombosis, 15 months after surgery for an AAA. Duplex ultrasonography scan (DUS), performed 8 months after EAB surgery, showed graft's patency and a 40 × 250 mm diameter capsulated PS along the EAB graft left branch. Seroma was initially drained by percutaneous puncture. Because of its rapid recurrence, 3 months later the patient underwent a left branch excision and replacement with a Dacron graft. After 17 months from replacement, no periprosthetic collections are detected by DUS. The patient has always remained asymptomatic.

Case 2

A 70-year-old woman showed an asymptomatic swelling in correspondence to Dacron AxBF bypass graft, performed 2 years before for aorto-enteric fistula (AEF) and aorto-bifemoral bypass graft infection. Blood tests showed no abnormalities. CT-scan with contrast media (CTA) revealed periprosthetic collection along the whole bypass course, more visible in the suprapubic tract, with a maximum diameter of 128 mm. At first, the patient underwent PS surgical drainage and muscular wrapping of the graft in the axillary and suprapubic region. A second surgical drainage with total PS capsule removal till the breast region was performed 15 months later because of recurrence. Capsule microscopic examination revealed mature connective tissue with congested and swollen vessels, focal extravasation bleeding, and acute inflammation. A new relapse complicated by *Staphylococcus aureus* spp. graft infection required a complete EAB graft replacement with a new PTFE graft. Twenty-two months later, no PS recurrence was observed by CDUS examination.

Case 3

Our recent publication[5] described a 75-year-old man with a tender and pulseless suprapubic mass, painful when coughing. The patient had a history of Leriche's syndrome treated by right Dacron AxBF bypass performed 2 years earlier. A CT-scan showed the presence of a 121-mm diameter giant PS, extending from the bifurcation to the anastomosis of the receiving limb. The bypass was patent and no visible signs of periprosthetic infection were demonstrated. The patient subsequently underwent surgical drainage of the mass content, removing the capsule and the affected graft portion, with reconstruction of the contralateral bypass branch in expanded polytetrafluoroethylene (ePTFE 8 mm) graft. PS contained serous and sterile fluids. Fibrous and adipose tissue with vascular ectasia, extravasations, and chronic inflammation were found in the pseudocapsule specimen. Six months later, a DUS revealed a modest, periprosthetic,

asymptomatic PS recurrence. The patient has not yet undergone reoperation due to comorbidities.

Case 4

A 70-year-old man suffering from a 6.7-cm AAA underwent EVAR with left AUI stent graft (Zenith Flex; Cook Medical, Bloomington, IN) and left to right Dacron knitted FF crossover bypass graft. Twelve months after surgery, DUS revealed a 57 × 31 mm right FF anastomosis PS. First, the patient underwent surgical drainage and muscle flap coverage of the graft. A second surgical drainage was performed 4 months later because of recurrences. Eight months later, an *Staphylococcus aureus* spp. prosthetic infection occurred and the FF crossover bypass graft was replaced with an 8-mm silver-coated Dacron graft. Intraoperative findings showed a well healed left anastomoses, whereas the right one appeared unstuck from surrounding tissues. The DUS performed 1 year after surgery showed extra-anatomic graft patency with no new signs of periprosthetic collections.

Case 5

An 84-year old man with a clinical history of hypertension, chronic lymphocytic leukemia, and chronic occlusion of the right common iliac artery underwent EVAR for an 8.25 cm AAA. A left AUI stent graft (Endurant II; Medtronic, Santa Rosa, CA) together with a left to right FF PTFE bypass graft were performed.

Approximately 1 month after EVAR, he came back to our department because of a small, painless mass along the FF bypass, particularly close to the left section. Conservative therapy was useless and 3 weeks later percutaneous aspiration was performed, with complete recovery. DUS performed 6 months later revealed graft patency and mild asymptomatic recurrence.

METHODS

We retrospectively investigated all EAB grafts performed at our division between January 1, 2002 and December 31, 2015 and detected, among these, all cases of PS, referring to the definition offered by Blumenberg: ''a collection of clear, sterile fluid, confined within at nonsecretory fibrous pseudomembrane surrounding a vascular graft.''[10]

A review of the current literature on main international scientific medical databases (PubMed, EMBASE, Scopus) was simultaneously conducted, using as keywords the terms ''perigraft seroma,'' ''perigraft hygroma,'' ''extra-anatomical bypass graft,'' and ''vascular surgery complication,'' with no language or time filters. We took into account exclusively cases of PS following EABs (AxBF, AxF, or FF). Articles describing patient and bypass characteristics, first surgical procedure, diagnostic process, therapeutic methods, and clinical outcomes were included in the analysis.

RESULTS

During the study period, 797 lower limb bypasses have been performed in our division. Among these, 528 (66.3%) anatomic and 269 (33.7%) extra-anatomic (among these 169 FF, 20 AxF, 22 AxBF, and 58 AUI + FF) were realized. Five PS (1.86%) among EAB population (3 after AxBF and 2 after AUI + FF) occurred. One case occurred after a femoro-popliteal bypass was excluded from the analysis. Table I shows own case series characteristics and outcomes.

Patients involved were 3 men and 2 women with an average age of 75 ± 5 years. PS diameters at diagnosis were between 57 and 250 mm. Graft material implicated was Dacron knitted in 3 cases and PTFE in those remaining. The graft was patent in all patients at the time of PS diagnosis.

Conservative approach with percutaneous drainage was initially performed in 2 cases, while surgical drainage without graft removal was chosen for 3 patients. In 4 cases, because of the high recurrence rate, patients had been subjected to a subsequent invasive approach with surgical drainage and affected graft substitution. The replacement was performed in all cases with grafts of different materials. The liquid collected was always clear and sterile. Two pseudocapsules were analyzed with no interesting results. Graft's muscular coverage was performed in just one case although being ineffective for recurrence of PS.

Literature review showed 20 additional cases of PS after extra-anatomical bypass (Table II): 15 men, 1 woman, and 4 cases not specified.[9–20] Patients' average age reported was 68 ± 11 years (16 cases analyzed). Indications for primary surgery were aortic or aorto-iliac occlusion (7 cases), aorto-bifemoral ABF bypass (2 cases) or AAA infection (1 case), and lower limb revascularization or AAA correction in HRP (4 cases). In one case, the procedure was performed for AEF, in another one for noncomplicated AAA, and in a third case for contralateral AxBF thrombosis. Seven AxFs (3 right AxFs, 3 left AxFs, 1 not specified), 11 AxBFs, and 1 AUI endograft + FF bypass graft were described.

Table I. Own case series

Author, year	No.	Sex	Age	Procedure	Graft type	Maximum diameter (mm)	Time for diagnosis	Symptoms	Therapy	Outcome
Present cases, 2016	1	Female	75	AxBF for ABF bypass graft thrombosis	PTFE	40 × 250	8 months	Asx	Multiple drainage, then replacement with PTFE graft	No recurrence at 17 months
	2	Female	70	AxBF for secondary AEF	Dacron	128	2 years	Asx	Surgical drainage → graft infection, then replacement with PTFE graft	No recurrence at 22 months
	3	Male	75	AxBF for Leriche syndrome	Dacron	121	2 years	Discomfort	Surgical drainage, then replacement with ePTFE graft	Mild recurrence at 6 months
	4	Male	70	EVAR + FF	ePTFE	57 × 31	1 year	NS	Multiple surgical drainage + subfascial packaging, then replacement with Dacron graft	No recurrence at 12 months
	5	Male	84	EVAR + FF	PTFE	NS	28 days	Asx	Percutaneous drainage	Mild recurrence at 6 months

Asx, asymptomatic; NS, not specified.

The prosthetic material used was Dacron (10 cases) or PTFE (9 cases). In one case, no information regarding graft material was specified. The time interval between graft insertion and manifestation of seroma was quite variable (median 3 months; interquartile range 2−16 months).

All studies published reported patency of the EAB at the time of PS diagnosis. The maximum diameters of PS were declared only in 3 cases. In half of the reported cases symptoms were described and most patients were asymptomatic.

Therapy was conservative in 4 cases; local compression (1 case), fibrin sealing technique (1 case), percutaneous drainage (2 cases), surgical drainage (2 cases), multiple drainages followed by graft replacement and seroma removal (7 cases), and primary surgical graft removal (2 cases). In one case, microfibrillar collagen (MFC) was injected into the seroma after multiple surgical drainage and graft replacement. The drained clear serous fluid was sterile in all cases. When the surgical option was preferred to treat PS, all patients were submitted to graft removal and replacement, with a different prosthetic material (7 cases from Dacron to ePTFE, 3 cases from ePTFE to Dacron).

The follow-up period of the analyzed studies was rather variable (from a few days up to 4 years) and there were no enlargements or recurrence, with the exception of one case where continuous percutaneous drainage was necessary to control rapid recurrence.

DISCUSSION

The real prevalence of PS is difficult to estimate and data collected from literature refer to monocentric case series or surveys and date at least 25 years ago.[6−8] Current literature does not offer review regarding PS development after AUI and FF bypass.

In our experience, the incidence of PS after EABs was lower compared with the one reported in the literature although it remains still uncertain, for the reasons previously described.

The etiology of PS remains still unidentified. Several hypotheses have been advanced to explain the serum accumulation after vascular graft implants, including both graft- or patient-related factors, although the pathogenesis appears to be multifactorial. The most likely theories include *host versus graft* reaction,[9] *pseudoinfection*,[21] immunoallergic reaction,[6,22] ultrafiltration,[8,10] anomalous graft incorporation,[23−26] failure of wound repair process,[26] fibroblast transformation[7] with fluid exudation by *neobursa*, and intraoperative lymphatic damage.[27]

Table II. Current literature results

Author, year	No.	Sex	Age	Procedure	Graft type	Maximum diameter (mm)	Time for diagnosis	Symptoms	Therapy	Outcome
Kaupp, 1979[9]	1	NS	NS	AxBF for AEF	Dacron	NS	8 weeks	NS	Antibiotics irrigation and drainage, then replacement with PTFE graft	No complications at 26 months
	2	NS	NS	AxBF	Dacron	NS	10 weeks	Mild erythema	Replacement with PTFE graft	No complications at 26 months
	3	NS	NS	AxBF	Dacron	NS	24 weeks	Mild erythema	Replacement with PTFE graft	No complications at 26 months
Blumenberg, 1985[10]	4	Male	65	AxF(R) for iliac occlusion in HRP	PTFE	NS	8 weeks	NS	Multiple drainage, then replacement with Dacron graft	No recurrence at 38 months
	5	Male	86	AxF(L) for iliac and femoral occlusion	PTFE	NS	1 month	NS	Multiple drainage	Progressive diminution at 9 months
	6	Male	63	AxBF for infected AAA	Dacron	NS	3 years	Asx	None	Progressive diminution at 2 years
Buche, 1986[11]	7	Male	65	AxF(L) for aortic barrage after contralateral amputation	ePTFE	NS	6 months	NS	Punctured percutaneously, then drained surgically	Rapid recurrence if not drained periodically. Graft patency at 2 years
	8	Male	39	AxF(L) for ABF bypass failure after contralateral amputation	ePTFE	NS	7 months	NS	None	No seroma enlargement and graft patency at 14 months
	9	Male	63	AxBF for aortic occlusion	PTFE	NS	3 months	NS	None	No seroma enlargement and graft patency at 5 months
Rhodes, 1986[12]	10	Male	63	AxBF for AAA in HRP	Dacron	NS	NS	NS	Multiple drainage, then replacement with PTFE graft. After recurrence, MFC injection	No fluid accumulation at 3 months
IIzima, 1991[13]	11	Male	70	AxF(R) for PAD after contralateral amputation	ePTFE	NS	NS	Asx	Multiple drainage, then replacement with Dacron graft	No postoperative complication

Q9

(*Continued*)

Table II. Continued

Author, year	No.	Sex	Age	Procedure	Graft type	Maximum diameter (mm)	Time for diagnosis	Symptoms	Therapy	Outcome
Inari, 2005[14]	12	Male	77	AxBF for aortic occlusion	Dacron	NS	2 months	NS	Multiple drainage, then replacement with ePTFE graft	No postoperative recurrence
	13	Male	60	AxF(R) for iliac occlusion in a patient with hostile abdomen	Dacron	NS	9 days	Asx	None	No postoperative recurrence
	14	Male	77	AxBF in HRP	Dacron	NS	26 days	NS	Local compression	NS
Zanow, 2010[15]	15	NS	NS	AxF	ePTFE	NS	32 months	NS	FST	No recurrence. Patient died 28 months later
Fukunaga, 2013[16]	16	Male	81	AxBF for ABF graft infection	ePTFE	NS	NS	Asx	Surgical drainage	No recurrence at discharge
Ho, 2013[17]	17	Male	79	AxBF for infected ABF Dacron graft	Dacron	90	2 years	Discomfort	Multiple drainage, then replacement with PTFE graft	No recurrence. Patient died 4 years later
Romera Barba, 2015[18]	18	Female	76	EVAR + FF	NS	98	3 years	Inguinal pain	Percutaneous drainage	No recurrence at 3 years
Gazi, 2015[19]	19	Male	54	AxBF for aortic thrombosis in HRP	ePTFE	NS	7 weeks	Discomfort	AxBF explantation, then ABF Dacron bypass replacement	No recurrence at 12 months
Kunimoto, 2015[20]	20	Male	75	AxBF(L) for AxBF(R) thrombosis after mycotic AAA	Dacron	90 × 130	8 months	NS	Multiple drainage, then replacement with PTFE graft	No recurrence at 13 months

Asx, asymptomatic; FST, fibrin sealing technique; NS, not specified.

There is no consensus regarding the preferential use of Dacron or PTFE to prevent PS formation.

Advances in prosthetic materials manufacture could have contributed to reducing the occurrence of PS during the years. On account of the fact that PS also occurred after subfascial graft coverage, we assume that graft material should be involved in the process of fluid collection more than the periprosthetic environment. Moreover, partial incorporation of the graft at the anastomotic site was also observed in our series (cases 4 and 5).

Therapeutic indications are not yet well defined. The treatment can be conservative, mini-invasive, or surgical, although when necessary, graft replacement is often needed.

Watchful waiting with DUS follow-up and compressive therapy is preferred in mild and asymptomatic PS. Zanow recommends conservative approach for seromas < 2 cm in diameter, without anastomotic region involvement.[15]

If invasive treatment is needed, the therapy aims to remove the swollen mass, to decrease symptoms associated, to minimize PS recurrence rate, and to avoid bypass occlusion and/or infection. Although some authors support a primary mini-invasive approach with percutaneous drainage,[9,13,14,17,18] this is not recommended considering its high recurrence rates and risks of seroma and, therefore, graft infection. In our series, in fact, we have performed PS drainage (with DUS control) mainly to delay surgery in HRP with larger PS.

When needed, graft replacement with one of different material appears to be the most definitive treatment and can involve a decrease in graft permeability and periprosthetic reaction to foreign body. There is no difference in Dacron to ePTFE replacement or vice versa. Pseudocapsule's removal and surgical drainage alone should be avoided, since not curative and causing a high rate of infection.[10] Replacement with homograft[28] or native vein,[29] saphenous vein wrapping,[30] interposition of covered stents,[31] and MFC injection into the periprosthetic space[12] are alternative therapies tested in a very limited number of cases. Plasmapheresis[24] and intravenous fibrinogen administration[32] were performed to wash out hypothetical serum factors regarded as likely to modify the normal graft permeability.

A fundamental issue in PS management is patient counseling. It is extremely important to reassure these patients on the kindness of such complication. Even so, these patients often appear very apprehensive and continuously requesting explanations on the nature of the growing mass, particularly when a complicated past medical history exists.

Treatment decision-making process should always take into account important issues such as PS dimension and growth rate, symptomatology, and patient's condition. Due to the lack of dimensions' data in the literature, absolute treatment recommendations remain aleatory and thereby therapy is often patient-tailored. Our cases have larger diameters if compared with those reported in the literature. Therefore, we assume that the greater the size of PS, the greater is the indication for surgical replacement therapy, although there are no specific cutoff values. A complete removal of the pseudocapsule together with graft material replacement of the affected portion is mandatory. Histopathological analysis of perigraft fluid, pseudocapsule, and explanted graft specimen may be avoided if no signs of infection are detected.

CONCLUSION

PS is a rare complication that can occur even after several years from graft placement. Triggering factors are not yet clarified, although graft-related and patient-related elements may play a role in periprosthetic fluid's accumulation. Several therapeutic options have been proposed, but none have reached satisfactory results in a sufficient number of cases. In our experience, both conservative treatment and percutaneous/surgical drainage proved to be futile, due to a higher risk of prosthesis infection and PS recurrence. Graft removal and replacement with another material had the best results, although not yet optimal. Anyways, very few and selected patients beneficiate from surgery which, on the basis of our experience, is worthy only in case of greater swelling and/or growing masses with reported inability to walk, discomfort, or pain. Regarding EABs, we recommend a long-term follow-up after surgery, to assess graft patency and any periprosthetic fluid collection worthy of further investigation.

REFERENCES Q8

1. Dortch JD, Oldenburg WA, Farres H, et al. Long-term results of aortouniiliac stent grafts for the endovascular repair of abdominal aortic aneurysms. Ann Vasc Surg 2014;28:1258–65.
2. Quiñones-Baldrich J, Hernandez J, Moore W. Long-term results following surgical management of aortic graft infection. Arch Surg 1991;126:507–11.
3. Blaisdell WF. Development of femoro-femoral and axillo-femoral bypass procedures. J Vasc Surg 2011;53:540–4.
4. Lipsitz EC, Ohki T, Veith FJ, et al. Patency rates of femoro-femoral bypasses associated with endovascular aneurysm repair surpass those performed for occlusive disease. J Endovasc Ther 2003;10:1061–5.

5. Bissacco D, Domanin M, Del Gobbo A, et al. Giant perigraft seroma after axillobifemoral bypass for Leriche syndrome: a case report. Ann Vasc Dis 2016;9:252–4.
6. Ahn SS, Machleder HI, Gupta R, et al. Perigraft seroma: clinical, histologic, and serologic correlates. Am J Surg 1987;154:173–8.
7. Paes E, Vollmar JF, Mohr W, et al. Perigraft reaction: incompatibility of synthetic vascular grafts? New aspects on clinical manifestation, pathogenesis, and therapy. World J Surg 1988;12:750–5.
8. Borrero E, Doscher W. Chronic perigraft seromas in PTFE grafts. J Cardiovasc Surg (Torino) 1988;29:46–9.
9. Kaupp HA, Matulewicz TJ, Lattimer GL, et al. Graft infection or graft reaction? Arch Surg 1979;114:1419–22.
10. Blumenberg RM, Gelfand ML, Dale WA. Perigraft seromas complicating arterial grafts. Surgery 1985;97:194–204.
11. Buche M, Schoevaerdts JC, Jaumin P. Perigraft seroma following axillofemoral bypass: report of three cases. Ann Vasc Surg 1986;1:374–7.
12. Rhodes VJ. Perigraft seroma: simple solution to a difficult problem. J Vasc Surg 1986;3:939.
13. Iizima T, Izuo M, Yoshida I, et al. A case report of perigraft seroma occurred after axillo-femoral bypass operation. J Jpn Pract Surg Soc 1991;52:667–71.
14. Inari H, Mou M, Karube N, et al. Three case reports of seroma occurring after axillo-femoral bypass operation. Jpn J Vasc Surg 2005;14:709–12.
15. Zanow J, Kruger U, Settmacher U, et al. Treatment of perigraft seroma in expanded polytetrafluoroethylene grafts by sequential fibrin sealing of the outer graft surface. Ann Vasc Surg 2010;24:1005–14.
16. Fukunaga N, Yuzaki M, Nasu M. Sixteen-year previously implanted perigraft seroma. Indian J Surg 2013;75:151.
17. Ho KKF, Walker PJ, Cavaye DM. A case of large recurrent perigraft seroma after axillobifemoral bypass. EJVES Extra 2013;26:e1–3.
18. Romera Barba E, Gálvez Pastor S, Castañer Ramón-Llín J, et al. Perigraft seroma after femoro-femoral bypass. Cir Esp 2015;93:e15.
19. Gazi A, Staffa R, Novotný T, et al. Perigraft seroma as a rare angiosurgical complication. Rozhl Chir 2015;94:477–81.
20. Kunimoto H, Nishimura Y, Honda K, et al. Giant perigraft seroma after axillo-bifemoral bypass. Jpn J Vasc Surg 2015;24:1021–4.
21. Szilagyi DE: in Discussion Kaupp HA, Matulewicz TJ, Lattimer GL, et al. Graft infection or graft reaction?. Arch Surg 1979;114:1419–22.
22. Bhuta I, Dorrough R. Noninfectious fluid collection around velour dacron graft: possible allergic reaction. South Med J 1981;74:870–2.
23. Ahn SS, Williams DE, Thye DA, et al. The isolation of a fibroblast growth inhibitor associated with perigraft seroma. J Vasc Surg 1994;20:202–8.
24. Sladen JG, Mandl MA, Grossman L, et al. Fibroblast inhibition: a new and treatable cause of prosthetic graft failure. Am J Surg 1985;149:587–90.
25. Schneiderman J, Knoller S, Adar R, et al. Biochemical analysis of a human humoral fibroblast inhibitory factor associated with impaired vascular prosthetic graft incorporation. J Vasc Surg 1991;14:103–10.
26. Pricolo VE, Potenti F, Soderberg CH. Effect of perigraft seroma fluid on fibroblast proliferation in vitro. Ann Vasc Surg 1991;5:462–6.
27. Williams GM. The management of massive ultrafiltration distending the aneurysm sac after abdominal aortic aneurysm repair with a polytetrafluoroethylene aortobiiliac graft. J Vasc Surg 1998;28:551–5.
28. Vince DJ, LeBlanc JG, Culham JA. Recurrent perigraft seroma treated by graft replacement with homograft iliac artery. Pediatr Cardiol 1989;10:113–4.
29. Sobrinho G, Henriques SP. Perigraft seromas complicating prosthetic bridge arteriovenous fistula—solution with autogenous vein interposition. Eur J Vasc Endovasc Surg 2001;22:469–71.
30. Imren Y, Qaradaghi L, Oktar GL, et al. Saphenous vein wrapping for the treatment of a perigraft seroma: report of a case. Surg Today 2011;41:549–51.
31. Gargiulo NJ 3rd, Veith FJ, Scher LA, et al. Experience with covered stents for the management of hemodialysis polytetrafluoroethylene graft seromas. J Vasc Surg 2008;48:216–7.
32. Hiramatsu Y, Atsumi N, Sasaki A, et al. A successful treatment of serous leakage from a polytetrafluoroethylene Blalock-Taussig shunt with intravenous fibrinogen administration. J Thorac Cardiovasc Surg 1999;117:1230–1.