OUTCOMES AFTER RETROFLEXED GRACILIS MUSCLE FLAP FOR VASCULAR INFECTIONS IN THE GROIN

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Abstract

Background: After femoral artery reconstructions, Groin wound complications are very fatal and difficult to treat. Long-term antibiotic medication, surgical debridement, and muscle flap covering are all effective methods. Our research analysed the effectiveness of a modified gracilis muscle flap (GMF) for covering up problems in the groyne area following synthetic graft artery bypass surgery.

Methods: This was a prospective study. It included all individuals who had groyne infections after having synthetic grafts placed in their lower limb arteries that participants who underwent a GMF were considered in Damietta Faculty of medicine IRB – Al-Azhar University from May 2020 to May 2022

Results: according to Microbiology among the studied cases there were 48 (48%) Never cultured, 11 (11%) with enterococcus faecalis, 26 (26%) with pseudomonas and 15 (15%) with staphylococcus aureus, according to Successful treatment there were 15 (15%) failed and 85 (85%) succeeded, according to in-hospital death there were 5 (5%) died, according to complications there were 7 (7%) with anastomosis disruption, 2 (2%) with hematoma, 1 (1%) with necrosis of flap, 2 (2%) with persistent infection, 3 (3%) with sepsis and 5 (5%) with seroma.

Conclusion: When difficulties arise in the groyne area following synthetic graft-based artery bypass surgery, GMS is a viable alternative for covering the exposed tissue. Gracilis muscle flap covering may be an effective alternative to total graft removal and extra-anatomic bypass in carefully chosen patients with vascular reconstructions and groyne infection. The procedure is straightforward, and the morbidity associated with gracilis muscle harvest is usually rather low.

Keywords: Groin; Infection; Muscle flap; Outcome; Wounds.

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INTRODUCTION

The groin is a common site for both natural and artificial vascular infections. The closeness of the groin to the perineum, the relatively superficial site of vascular grafts in the groin, and the development of wound infection proximal to a vascular graft are the key risk factors for vascular groin infection **(1,2).**

The patient's life and the injured limb are in danger. Massive bleeding, systemic infections, severe limb ischemia, and septic embolization are all possible consequences **(3)**.

Excision of the infected segment or graft, proper debridement, and restoration of circulation are necessary for the effective treatment of arterial or prosthetic graft infection. Either in-situ or extra-anatomic prosthetic bypass may be used to restore arterial blood flow. This is because vascularized musculocutaneous flaps reduce dead space, improve local oxygenation, and are linked to less bacterial inoculation near wound sites **(4,5).**

The sartorius muscle is the most often utilized muscle flap for groin covering because it is simple to dissect and does not need a second incision. The sartorius muscle might be an alternative, however it might not be able to cover a huge groin defect, or it could be too lateral to be dragged medially over the defect. If the sartorius muscle flap cannot be used, a gracilis muscle flap (GMF) may be an alternative for patients in need of covering.

Morasch *et al.* (8) and **Ali *et al*. (9)** both studied the use of GMFs in patients with groin problems, but they looked at the issue from different perspectives. Mobilization and retroflexion of the GMF via a tunnel into the groin defect without compromising the primary blood supply is the emphasis of the procedure evaluated by **Ali *et al.* (9).**

The purpose of this research is to assess the efficacy of a modified gracilis muscle flap (GMF) method for covering up problems in the groin area after synthetic graft arterial bypass surgery.

MATERIAL AND METHODS

This was a retrospective study done in New Damietta Hospital and was conducted on any person who had GMF to treat a groin infection.

Patients who came with a vein graft or were having GMF performed for reasons other than infection were not included. Each patient who participated in the research provided signed informed permission. All patients' ages, sexes, diagnoses (such as hypertension, diabetes, heart failure, stroke, and chronic kidney disease), and smoking histories were recorded.

Initiation of vascular procedures and graft type (autologous vein vs. synthetic) were documented. When the infection in each limb treated was gone, the skin and soft tissue above it healed, and no more antibiotics were needed, the therapy was considered effective. When the vascular anastomosis failed to heal or was disrupted due to chronic infection, the treatment was considered unsuccessful.

Elimination of infection and full recovery were the primary indicators of success. Limb salvage, GMF-related morbidity, and overall survival were considered secondary outcomes. Univariate and multivariate analysis of risk factors for a negative result was also conducted to compare synthetic and autologous material (vein).

Surgical Procedures:

Great care was taken to make a longitudinal incision in the medial thigh without cutting into the great saphenous vein (GSV). Assuming a recent harvest, the GSV was cut in the same way. Both the gracilis muscle and its tendon of insertion were located. The following criteria were used to confirm the gracilis' identity.

There are no perforating branches in the distal one-third of the gracilis muscle body, and the muscle becomes tendinous. Unlike the sartorius muscle, which remains rectangular even at its tendon, this one gradually narrows. Because the sartorius receives its blood supply in segments from the deep femoral artery, the gracilis can be distinguished from it (SFA). Ten) The surgeon's index finger can be slipped around the muscle with ease. This is a necessary action in the mobilization process. As much of the tendon as feasible is cut off at its distal end after it has been retracted proximally. The adductor longus muscle on both sides must be mobilized and dissected. There should be no nerves or other soft tissues in the area in front of the gracilis muscle. After that, the muscle is flexed proximally **(11)** to hide the femoral arteries and veins. We don't cut it from its proximal connection to the pubis or pass it via the adductor longus muscle. In addition, we don't cut off the medial circumflex artery branch by purpose. After that, two or three absorbable

sutures are used to fasten the GMF to the inguinal ligament and nearby tissue.

After freeing the gracilis muscle from the pubic bone, the authors of **Morasch *et al.* (8)** rerouted it via the adductor longus muscle.

Figure (1): Surgical Procedure

Statistical analysis: IBM's statistical program, SPSS, version 20.0, was used to examine the data had been fed to the computer. Armonk, New York: IBM Corp. Statistics and percentages were used to describe the qualitative data. To ensure a normally distributed sample, we employed the Kolmogorov-Smirnov test. Minimal and maximum values, as well as the mean, standard deviation, median, and interquartile range, were used to characterize the quantitative data. At the 5% level of significance, the findings were deemed to be significant.

RESULTS

Table (1) shows that the mean age of studied cases was 64.51 (±7.88 SD) with range (50-78), among the studied cases there were 24 (24%) females and 76 (76%) males, there were 18 (18%) having aortofemoral bypass graft, 13 (13%) having common femoral artery endarterectomy5% of

them were removed for endovascular aneurysm repair. 3% of patients had embolectomy, and 14% underwent femoral artery pseudoaneurysm repair., 27 (27%) having femoral popliteal bypass, 8 (8%) having femoral-femoral artery bypass/revision and 12 (12%) having repair femoral artery from catheter injury, there were 48 (48%) with FAP with intact skin, 17 (17%) with FAP with sinus tract and 35 (35%) with Ischemia/occult infection without FAP and there were 95 (95%) with one treated limb and 5 (5%) with two treated limbs.

Table (2) shows that according to Microbiology among the studied cases there were 48 (48%) Never cultured, 11 (11%) with *enterococcus faecalis*, 26 (26%) with *pseudomonas* and 15 (15%) with *staphylococcus aureus*, according to successful treatment there were 15 (15%) failed and 85 (85%) succeeded, according to in-hospital death there were 5 (5%) died, according to complications there were 7 (7%) with anastomosis disruption, 2 (2%) with hematoma, 1 (1%) with necrosis of flap, 2 (2%) with persistent infection, 3 (3%) with sepsis and 5 (5%) with seroma, the mean follow-up was 30.96 (±26.38 SD) with range (0-80) months and in total there were 7(7%) who died and 3)3%) with amputation.

Kaplan-Meier survival curve for Time from Initial Surgery to adverse event shows that the occurrence of adverse events was more significant in failed operations than successful ones with mean duration in failure group 32.919 compared to 79.0 in success group. With 40% of survivors in failure group compared to 98.8% in success group (Table 3, Figure2).

Table (1): Distribution of the studied cases according to personal data

		Cases	
Age	Range.	50 – 78	
	Mean ± SD.	64.51 ± 7.88	
Gender	Females	24	24.0
	Males	76	76.0
Original surgery	Aortofemoral bypass graft	18	18.0
	Common femoral artery endarterectomy	13	13.0
	For endovascular aneurysm repair, Cut down	5	5.0
	Embolectomy	3	3.0
	Repair of a femoral artery pseudoaneurysm	14	14.0
	Femoral popliteal bypass	27	27.0
	Femoral-femoral artery bypass/revision	8	8.0
	Femoral artery repair after catheter damage	12	12.0
Clinical Presentation	FAP with intact skin	48	48.0
	FAP with sinus tract	17	17.0
	Ischemia/occult infection without FAP	35	35.0
No. of treated limbs	1	95	95.0
	2	5	5.0

Table 2: Distribution of studied cases as regard outcome

		Cases	
Microbiology	Never cultured	48	48.0
	Enterococcus faecalis	11	11.0
	Pseudomonas	26	26.0
	Staphylococcus aureus	15	15.0
Successful treatment	Failure	15	15.0
	Success	85	85.0
In-hospital Death	No	95	95.0
	Yes	5	5.0
Complications	Non	80	80.0
	Anastomosis disruption	7	7.0
	Hematoma	2	2.0
	Necrosis of flap	1	1.0
	Persistent infection	2	2.0
	Sepsis	3	3.0
	Seroma	5	5.0

Total adverse events	None	90	90.0
	Amputation	3	3.0
	dead	7	7.0
Time of death	Range.	0 – 80	
	Mean ± SD.	32.28 ± 27.13	

Table (3): Kaplan-Meier survival curve for Time from Initial Surgery to adverse events

	Mean (Month)	Survival%	Log Rank	
			χ^2	p
Failure	24.074	40.0	44.019*	<0.001*
Success	74.703	98.8		

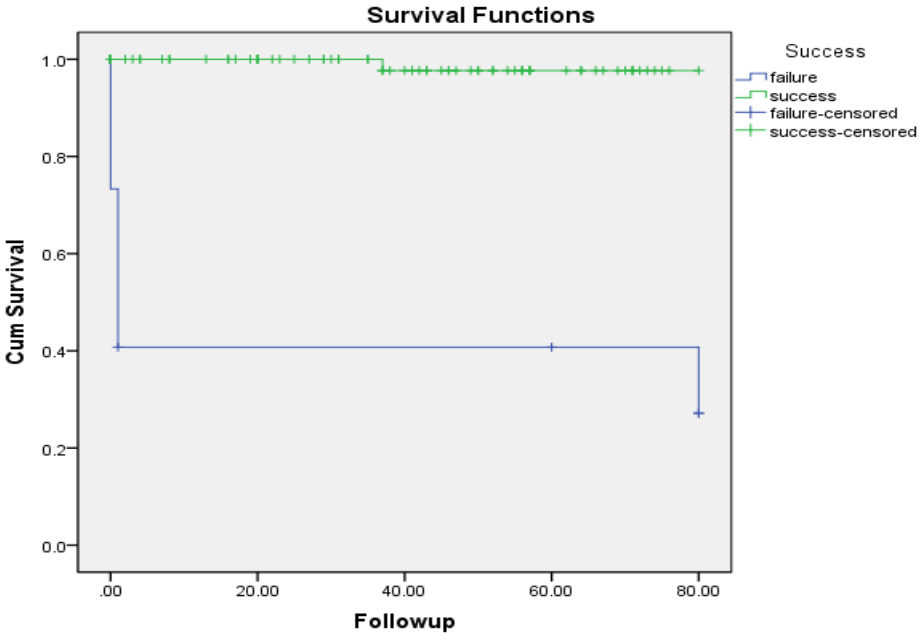

Figure (1): Kaplan-Meier survival curve for Time from Initial Surgery to Death

DISCUSSION

After vascular surgery, it is normal for the femoral wound to get infected or to simply fail to heal. Because this is so frustrating, it is especially problematic when prosthetics are at play. Infection of a bypass patient's prosthetic graft occurs between 0.7% and 7% of the time; femoral incisions are the most prevalent source of sepsis **(12).** During debridement, the bypass graft or native veins are commonly exposed because of the presence of nonviable groin tissue **(13).**

When healing of a groin incision is prolonged due to many repeat surgeries or in conjunction with chronic lymphatic leakage, there is a similar risk of vascular exposure. Most writers recommend graft removal and extra-anatomic rebuilding if prosthetic material gets exposed **(13).** However, depending on the specifics of the reconstruction or the presence of serious co-morbidities, this option may not always be practical. A few writers have recommended using muscle flaps to cover incisions to treat incisional breakdown or groin infection **(14).**

In some cases, it has been recommended to deploy a muscle flap to protect exposed native arteries or to recover prosthetic material during arterial restoration **(15).**

In rare circumstances, a pedicled muscle flap might help save an exposed prosthesis by creating a better wound-healing environment in the affected area. The transposed muscle serves as a highly vascular organ, able to supply the concealed area with oxygenated blood **(16).**

There seems to be a dearth of research assessing the efficacy of using a modified gracilis muscle flap (GMF) to cover up problems in the groin after synthetic graft artery bypass surgery.

Our findings revealed that, according to Microbiology among the studied cases there were 48 (48%) Never cultured, 11 (11%) with

Enterococcus faecalis, 26 (26%) with Pseudomonas and 15 (15%) with Staphylococcus aureus. Research suggests that a prosthetic transplant must be removed entirely if it becomes contaminated with gram-negative organisms, such as Pseudomonas species, or a fungus **(17).**

Seven groyne wounds (35%) had polymicrobial infections; six of these included at least one gram-negative organism. This is in line with the findings of **Morasch *et al*. (8)** who studied a group of 18 patients who underwent flap procedures from 1 week to 7 months after the index revascularization procedure by mobilising the gracilis muscle from the pubic bone and passing through the adductor longus muscle. The intraoperative culture grew no germs from two groynes (10%). Pseudomonas species were cultivated from four of the 14 groyne wounds, while Candida was cultured from another. Methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococcus were found in the systems of two individuals.

Our data showed that 85 out of 90 patients were successfully treated, with just 5 patients dying while in the hospital. According to our findings and those of **Morasch *et al.* (8),** local wound care was effective in all patients. In the end, 19 out of 20 groynes (95% success rate) healed well, and 11 out of 13 patients (85%) had their prosthetic grafts successfully salvaged.

Regarding complications, our data are in line with **Morasch *et al.* (8)** who reported that eleven out of eighteen patients (61%) are still alive after problems related to necrosis hematoma. A patient who declined hip disarticulation and had gracilis flap insertion instead died two and a half months later. One patient who had had a thoraco-femoral and femoropopliteal bypass had a fatal myocardial infarction three months after the procedure was covered. A stroke, congestive heart failure, complications from renal failure, and metastatic cancer all contributed to the deaths of four individuals 8, 14, 22, and 28 months following the flap operation. There have been no more cases of recurrent groyne infections, and no additional amputations, among survivors at the mean follow-up time of 40 ± 10 months.

Our results stated that, the occurrence of adverse events was significant in failed operations than successful ones with mean duration in failure group 32.919 compared to 79.0 in success group. With 40% of survivors in failure group compared to 98.8% in success group.

Previous research suggested that MFCs derived from these muscles had a high initial success rate in treating the specified wounds and preserving limb function. Early death rates varied from 0% to 24%; this shows that these treatments are too intrusive for frail patients with graft infections, hence the reasons should be carefully established. The criteria for this invasive therapy for graft infection should be carefully established since patients with graft infection are generally nutritionally deprived, with major comorbidities, and graft infection is not the only concern (18).

Majority of infected limbs (58 out of 68) were effectively treated, according to **Ali *et al.* (9).** No more surgical procedures were necessary, and these individuals did not need to stay on antibiotics for an extended period before being released. Antimicrobial therapy for survivors was limited to a maximum of 6 weeks before patients were released.
The usage of a GMF has been documented in early investigations with promising intermediate outcomes. So far, this is the most comprehensive report of a GMF for complicated groyne wounds after vascular surgeries **(7).**

Patients who had a gracilis flap over synthetic graft with initial skin closure had the greatest rate of therapeutic failure. Prior to committing a patient to this sort of operation, it is crucial to evaluate the patency of the donor flap vessels **(9).**

An early intraoperative examination of the patency of the vascular pedicle with a portable Doppler scanning probe is recommended, as is a review of the magnetic resonance imaging or contrast-enhanced angiography before continuing. Although one flap died due to occlusion of a repaired deep femoral artery, gracilis muscle harvest has never been aborted due to lack of blood supply.

Otherwise, when more definitive treatment is not an option for controlling incisional breakdown and sepsis following vascular surgery, we have found that covering the incision with a gracilis muscle flap is the most effective and recommended way.

There are several benefits to using GMF instead of the more common rotational muscle flaps, despite the fact that the flap harvest process may be more difficult than that utilised to make a sartorius muscle flap. As a first point, the sartorius muscle's blood supply — the superficial femoral artery — is frequently blocked in patients with vascular disease. As a result, the sartorius muscle, which is

fed by a separate section of blood vessels, is often impaired in these people. Since three or more pedicles often need to be ligated to provide appropriate mobility of a sartorius flap for usage in the infected groin area, the segmental arrangement is also a significant factor **(19).**

As opposed to what has been reported **(20),** the GMF really receives its blood supply from a single branch of the profunda femoral artery, which is less susceptible to atherosclerosis than the superficial femoral artery.
Getting a muscle from a spot that isn't infected, isn't near the bypass conduit, and is easy to shut up afterward is also helpful **(21).** For septic groyne reconstruction, a GMF is obviously superior to the rectus femoral flap and the rectus abdominal flap in terms of morbidity and functional outcomes **(22).**

Results from 30 studies comparing GMS, sartorius muscle flap (SMF), and rectus femoris muscle flap (RFF) outcomes were pooled, and the following rates were found: There was a necrosis of 4.5% of the muscle, 21.8% overall complications, 8.0% limb loss, 15.4% graft loss, and 7.4% 30-day mortality. The rates of overall complications were 20.3% and 18.0% for the SMF, RFF, and GMF, respectively. GMF members lost the most body parts overall (17.2%; 95% CI, 4.237.2%; I2 = 0%). Muscle flap restoration for infected groyne wounds after vascular surgery, they found, is both successful and safe **(5).**

Our study had several restrictions. In the end, we didn't consider other potential dangers including diabetes, smoking, BMI/obesity, hypertension, and coronary artery disease. Unfortunately, we were unable to identify the best graft technique to use. Unfortunately, we were unable to ascertain which antibiotic was used and for how long.

Conclusion:
When difficulties arise in the groin area following synthetic graft-based artery bypass surgery, GMS is a viable alternative for covering the exposed tissue. Gracilis muscle flap covering may be an effective alternative to total graft removal and extra-anatomic bypass in carefully chosen patients with vascular reconstructions and groyne infection. The procedure is straightforward, and the morbidity associated with gracilis muscle harvest is usually rather low.

Based on intraoperative culture findings, it is now recommended that patients with autogenous reconstructions be treated with intravenous antibacterial drugs for 6 weeks, and patients with patent prosthetic grafts be treated for as long as 1 year. It's crucial to remember that many infections caused by prosthetic grafts are probably not completely wiped out, and that many patients may continue to carry germs in low concentrations for a long time.

Declarations
Ethics approval and consent to participate.
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Competing interests
The authors declare that they have no competing interests.

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REFERENCES
1. Dosluoglu HH, Loghmanee C, Lall P, Cherr GS, Harris LM, Dryjski ML. Management of early (<30 day) vascular groin infections using vacuum-assisted closure alone without muscle flap coverage in a consecutive patient series. J Vasc Surg. 2010 May;51(5):1160-6. doi: 10.1016/j.jvs.2009.11.053.
2. Wübbeke LF, Elshof JW, Conings JZM, Scheltinga MR, Daemen JHC, Mees BME. A systematic review on the use of muscle flaps for deep groin infection following vascular surgery. J Vasc Surg. 2020 Feb;71(2):693-700.e1. doi: 10.1016/j.jvs.2019.07.073.
3. Brewer MB, Ochoa CJ, Woo K, Wartman SM, Nikolian V, Han S, Weaver FA, Rowe VL. Sartorius muscle flaps for vascular groin wound complications. The American surgeon. 2015; 81(11): 1163-9.
4. Wallace AB, Piper ML, Holland M, Lee S, Orringer M, Eichler C, Kim EA, Hansen SL. Prophylactic Muscle Flaps in Primary Vascular Procedures of the Groin. Ann Vasc Surg. 2022 Jan;78:77-83. doi: 10.1016/j.avsg.2021.05.049.
5. Shimbo K, Kawamoto H, Koshima I. Use of Muscle Flaps for Salvage of Groin Wound Infection Following Vascular Surgery: A Systematic Review and Meta-Analysis. Vasc Endovascular Surg. 2022 May;56(4):401-407. doi: 10.1177/15385744211068342.
6. Tanaka K, Mii S, Ishida M, Guntani A, Kawakubo E, Tanaka S, Yoshiga R, Okazaki J. Salvage of infected prosthetic grafts at the groin or thigh using muscle flap coverage.

Annals of Vascular Diseases. 2020: oa-20. doi: 10.3400/avd.oa.20-00123
7. Dua A, Rothenberg KA, Lavingia K, Ho VT, Rao C, Desai SS. Outcomes of gracilis muscle flaps in the management of groin complications after arterial bypass with prosthetic graft. Annals of Vascular Surgery. 2018; 51: 113-8. DOI: 10.1016/j.avsg.2018.02.009
8. Morasch MD, Sam II AD, Kibbe MR, Hijjawi J, Dumanian GA. Early results with use of gracilis muscle flap coverage of infected groin wounds after vascular surgery. Journal of vascular surgery. 2004; 39(6): 1277-83. DOI: 10.1016/j.jvs.2004.02.011
9. Ali AT, Rueda M, Desikan S, Moursi MM, An R, Spencer H, Rueda S, Eidt JF. Outcomes after retroflexed gracilis muscle flap for vascular infections in the groin. Journal of Vascular Surgery. 2016; 64(2): 452-7. DOI: 10.1016/j.jvs.2016.03.010
10. Landry GJ, Carlson JR, Liem TK, Mitchell EL, Edwards JM, Moneta GL. The sartorius muscle flap: an important adjunct for complicated femoral wounds involving vascular grafts. The American journal of surgery. 2009; 197(5): 655-9. DOI: 10.1016/j.amjsurg.2008.12.020
11. Hasen KV, Gallegos ML, Dumanian GA. Extended approach to the vascular pedicle of the gracilis muscle flap: anatomical and clinical study. Plastic and reconstructive surgery. 2003; 111(7): 2203-8. DOI: 10.1097/01.PRS.0000060114.95065.C5
12. Gombert A, Barbati ME, Grommes J, Kurstjens RL, deWolf MA, Wittens CH, et al. Wound complications after common femoral vein endophlebectomy: Influence on outcome. Phlebology. 2018;33:407-17. DOI: 10.1177/0268355517714712
13. Azoury SC, Stranix JT, Kovach SJ, Levin LS. Principles of orthoplastic surgery for lower extremity reconstruction: why is this important? J Reconstr Microsurg. 2021;37:42-50. DOI: 10.1055/s-0039-1695753
14. May BL, Zelenski NA, Daluvoy SV, Blanton MW, Shortell CK, Erdmann D. Salvage of Exposed Groin Vascular Grafts with Early Intervention Using Local Muscle Flaps. Plast Reconstr Surg Glob Open. 2015;3:514-20. DOI: 10.1097/GOX.0000000000000480
15. Zoepke SN, de Weerd L. The Marriage of Sartorius and Tensor Fasciae Latae in Treating Vascular Prosthetic Graft Infections. Plast Reconstr Surg Glob Open. 2017;5:1274-9.DOI: 10.1097/GOX.0000000000001274
16. Mendenhall SD, Ben-Amotz O, Gandhi RA, Levin LS. A Review on the Orthoplastic Approach to Lower Limb Reconstruction. Indian J Plast Surg. 2019;52:17-25. DOI: 10.1055/s-0039-1688095
17. Ajdler-Schaeffler E, Scherrer AU, Keller PM, Anagnostopoulos A, Hofmann M, Rancic Z, et al. Increased Pathogen Identification in Vascular Graft Infections by the Combined Use of Tissue Cultures and 16S rRNA Gene Polymerase Chain Reaction. Front Med (Lausanne). 2018;5:169-75. doi: 10.3389/fmed.2018.00169
18. Tanaka K, Mii S, Ishida M, Guntani A, Kawakubo E, Tanaka S, et al. Salvage of Infected Prosthetic Grafts at the Groin or Thigh Using Muscle Flap Coverage. Ann Vasc Dis. 2020;13:404-9. doi: 10.3400/avd.oa.20-00123
19. Song P, Pu LL. The soleus muscle flap: an overview of its clinical applications for lower extremity reconstruction. Ann Plast Surg. 2018;81:109-16. DOI: 10.1097/SAP.0000000000001499
20. Price A, Contractor U, White R, Williams I. The use of vascularised muscle flaps for treatment or prevention of wound complications following arterial surgery in the groin. Int Wound J. 2020;17:1669-77. doi: 10.1111/iwj.13449
21. Wübbeke LF, Elshof JW, Conings JZM, Scheltinga MR, Daemen JHC, Mees BME. A systematic review on the use of muscle flaps for deep groin infection following vascular surgery. J Vasc Surg. 2020;71:693-700. DOI: 10.1016/j.jvs.2019.07.073
22. Scaglioni MF, Franchi A, Giovanoli P. Pedicled chimeric sensitive fasciocutaneous anterolateral thigh (ALT) and vastus lateralis muscle (VLM) flap for groin defect reconstruction: A case report. Microsurgery. 2018;38:423-6. DOI: 10.1002/micr.30157