The impact of superficial femoral artery (SFA) occlusion on the outcome of proximal sartorius muscle transposition flaps in vascular surgery patients

Ingolf Töpel, MD, Thomas Betz, MD, Christian Uhl, MD, and **Markus G. Steinbauer, MD,** *Regensburg, Germany*

Objectives: **To demonstrate the feasibility and safety of proximal sartorius muscle rotational flaps in patients with peripheral occlusive artery disease.**

Methods: **Retrospective analysis of 53 patients with 56 proximal sartorius muscle flaps. Indication for a flap procedure was postoperative calcitrant lymphorrhea in nine, graft at risk in 13, and graft infection in 34 procedures. Pre- and postoperative patencies of the superficial femoral artery (SFA) and profundal femoral artery (PFA) were documented. Flap viability, wound healing, and limb salvage were examined at follow-up.**

Results: **In 59% of the procedures in this series, the SFA was occluded. The PFA was patent in all patients. Flap viability (100% vs 94%), rate of new (4% vs 6%), and recurrent infections (9% vs 6%), loss of vascular reconstruction rate (9% vs 9%), and limb salvage rate (100% vs 88%) did not differ significantly between the SFA patent and the SFA occluded group. There were four new infections (7%) and three recurrent infections (5.5%) during follow-up, five of which led to a loss of reconstruction. In four of those five patients, the sartorius flap was viable. Two patients died during the immediate postoperative period from septic multi-organ failure (3%). At a median follow-up of 6.4 months, 54 flaps were viable and wound closure was achieved in all surviving 51 patients. Limb salvage rate was 93%.**

Conclusions: **Biologic protection procedures as local muscle flaps are vital adjuncts to vascular surgery techniques in the treatment of complicated wounds in the groin. Occlusion of the SFA in the presence of a patent PFA is not associated with an increased risk of flap loss in proximal sartorius muscle rotational flaps. (J Vasc Surg 2011;53:1014-9.)**

Due to anatomic properties and a high microbial load, the groin is prone to local wound complications after surgery. Calcitrant lymphorrhea and wound healing disturbances may lead to infections jeopardizing vascular reconstructions in that area. Deep soft tissue infection and skin breakdown make coverage of vessels and grafts difficult. After debridement, direct wound closure often is impossible.

The value of local muscle flaps in wound and graft complications in the groin are well documented.[1-3] According to Mathes and Nahai,[4] the sartorius muscle is supplied by segmental branches from the superficial femoral artery (superficial femoral artery [SFA], type IV circulation pattern, segmental supply). Therefore, vascular surgeons might hesitate to use the proximal sartorius muscle flap in patients with an occluded SFA. Ramasastry[5] described a different supply pattern over branches of the medial and lateral circumflex artery.

In this study, we analyze the pre- and postoperative arterial status of SFA and profundal femoral artery (PFA) in patients with a proximal sartorius muscle rotational flap. These data were correlated with clinical end points as flap survival, wound healing, recurrence of infection, and graft preservation.

PATIENTS AND METHODS

Over a period of 38 months (March 2007 to May 2010), 56 proximal sartorius muscle flaps were performed in 53 vascular surgery patients as biologic protection procedure. Indication, epidemiologic, and procedural data are shown in Tables I and II. At our institution, the standard treatment plan of patients with surgical site infections affecting a vascular graft (Szilagyi 3, prosthetic, bovine, or venous) includes a biologic protection procedure. In the groin, the proximal sartorius muscle flap is our first choice. In the special situation of impending or manifest infections of vascular reconstructions, independently from the vascular procedure, extensive debridement of all necrotic tissue was done. Mathes and Nahai described the standard surgical technique.[4] Muscle fascia lateral to the groin vessels and the femoral nerve is opened longitudinally. It is necessary only in few cases to extend the already existing groin

From the Department of Vascular and Endovascular Surgery, Krankenhaus Barmherzige Brüder Regensburg.

Competition of interest: Dr Töpel received financial support from Cook, Inc, Medtronic, Inc, and W. L. Gore and Associates, Inc. Dr Betz received financial support from Medtronic, Inc. Dr Steinbauer received consulting fees from Cook, Inc, Medtronic, Inc, W. L. Gore and Associates, Inc, LeMaitre, Datascope, and Schwarz Pharma/Otsuka.

Reprint requests: Ingolf Töpel, MD, Department of Vascular and Endovascular Surgery, Krankenhaus Barmherzige Brüder Regensburg, Prüfeninger Str 86, 93049 Regensburg, Germany (e-mail: ingolf.toepel@barmherzige-regensburg.de).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a competition of interest.

0741-5214/$36.00

doi:10.1016/j.jvs.2010.11.047

Table I. Patient population: Demographic data

	SFA patent	*SFA occluded*	*All*	P
Patients			53	
Sartorius flaps	23	33	56	
Unilateral/bilateral			50/3	
Sex (men/women)	18 (78%)/5 (22%)	26 (78%)/7 (22%)	44 (78 %)/12 (22%)	1.000
Age (years) mean	63	67	65	
median	67	67	67	
range	17-87	53-86	17-87	1.000
Risk factors				
Hypertension	17 (73%)	29 (88%)	46 (82%)	.826
Diabetes mellitus	5 (22%)	13 (39%)	18 (32%)	.464
Smoking	10 (43%)	23 (70%)	33 (59%)	.430
Hyperlipoproteinemia	6 (26%)	11 (33%)	17 (30%)	.886
Cardiac history				
Coronary heart disease	8 (34%)	12 (36%)	20 (36%)	.856
Previous CABG or coronary PTCA	5 (22%)	7 (21%)	12 (21%)	1.000
Associated diseases				
COPD	5 (22%)	4 (12%)	9 (16%)	.483
Renal insufficiency (Crea > 1.0 mg/dL)	6 (26%)	13 (39%)	19 (34%)	.644
Indication for flap procedure				
Infected graft	11 (48%)	23 (70%)	34 (61%)	.547
Graft at risk	8 (35%)	5 (15%)	13 (23%)	.304
Calcitrant lymphorrhea	4 (17%)	5 (15%)	9 (16%)	1.000
Simultaneous vascular procedure				
Autologous	13 (56%)	21 (64%)	34 (61%)	.965
Bovine/prosthetic	2 (9%)	8 (24%)	10 (18%)	.297
None	8 (35%)	4 (12%)	12 (21%)	.124

CABG, Coronary artery bypass graft; *COPD*, chronic obstructive pulmonary disease; *PTCA*, percutaneous transluminal coronary angioplasty.

Table II. Procedures

	SFA patent	*SFA occluded*	*All*
Operation sites	23	33	56
Initial vascular procedure			
Aorto-inguinal	9	6	15
Prosthetic	9	6	15
Aorto-bifemoral BP	5	4	9
Aorto-femoral BP	1	2	3
Iliaco-femoral BP	3		3
Xenogen (bovine Patch)			
Autologous			
Infrainguinal	14	27	41
Prosthethic	3	21	24
Femoro-femoral BP	2		2
Femoro-femoral CX-BP	1	1	2
Femoro-popliteal BP (supragenual)		9	9
Femoro-popliteal BP (infragenual)		8	8
Femoro-crural BP		3	3
Xenogen (bovine Patch)	5	2	7
TEA femoral artery	5	2	7
Autologous	6	4	10
Femoro-femoral vein BP	1		1
Femoro-popliteal vein BP (supragenual)		2	2
Femoro-popliteal vein BP (infragenual)		1	1
Embolectomy CFA/PFA artery	5	1	6

BP, Bypass; *CFA*, common femoral artery; *CX*, crossover; *PFA,* profundal femoral artery; *TEA*, thrombendarterectomy.

incision cranially to the anterior superior iliac spine. After exposure of the ventral side, the muscle is cut off its origin and the dorsal side is carefully mobilized. The vascular pedicles are preserved whenever possible. The muscle is transposed to the vessel and fixated with absorbable sutures. After meticulous bleeding control by the use of bipolar forceps and rinsing of the wound with normal saline solution, suction drains were placed over and under the flap and the wound was closed in single suture technique (32 operating sites). In cases where primary wound closure was not feasible due to defects or edema (24 operating sites) or in cases that were primarily closed but had to be reopened for incision edge edema (three cases), a vacuum-assisted wound closure device ([VAC] KCI International, San Antonio, Tex) was placed on top of the flap and run with continuous negative pressure of 75 mm Hg. The VAC device was changed every 3 to 4 days, until secondary wound closure could be achieved (12 operating sites) or the wound could be covered with a split thickness skin mesh graft (15 operating sites).

In eight patients of the SFA patent group and five patients of the SFA occluded group, the flap was done in a prophylactic manner, because the surgeon defined the condition of the vascular graft and the wound as prone to infection (graft at risk).

Calcitrant lymphorrhea was defined as lymphatic wound drainage of more than 50 cc per day for more than seven days postoperatively. Intraoperative wound swaps and cultures of explanted graft specimen were reviewed and the findings of microbiological analysis was documented in Table III. Pre- and postoperative angiographies and duplex-ultrasound findings were analyzed with respect to the patency of SFA and PFA. Flap viability, wound healing, graft preservation, and new and recurrent

Table III. Microbiologic spectrum

Species	*Graft infections N = 34*	*Recurrent infections N = 4*	*New infections N = 3*	*Failed flaps N = 2*	*Loss of reconstruction N = 5*
Staphylococcus aureus	8	2	1	0	1
Incl. MRSA	0	0	0	0	0
Enterococci	2	2	1	1	2
Incl. Ampicillin-resistant Enterococci	1	1	0	0	0
Coagulase-neagtive Staphylococci	8	2	2	2	3
Streptococci	4	0	0	0	0
Escherichia coli	2	1	0	1	1
Incl. ESBL	1	1	0	1	1
Pseudomonas aeroginosa	1	1	0	0	0
Acinetobacter baumannii	2	0	1	0	1
Enterobacter cloacae	1	1	0	0	0
Klebsiella	4	2	1	2	1
Incl. ESBL	1	1	0	1	1
Proteus	1	1	0	1	1
Candida	3	2	0	1	1
Negative culture	13	0	0	0	0
Two or more species cultured	7	3	2	2	2

infections were documented. At follow-up, vascular status, wound status, and functional result were examined.

Data were collected and analyzed using Microsoft Excel for Mac (Microsoft Corporation, Santa Rosa, Calif). Statistical comparisons were made using the χ^2 test with a P value less than .05 considered significant. If over 20% of the expected values in the contingency table were less than five, Fisher exact test was used because the χ^2 test can be quite inaccurate in this situation.

RESULTS

Fifty-six proximal sartorius muscle transposition flaps (30 on the right and 26 on the left side) were performed in 53 patients. Patient characteristics and detailed surgical data are given in Tables I and II. All angiographies and CT-scans of the immediate perioperative period were reviewed concerning the status of the SFA and PFA. Four patients with an occluded SFA had a patent proximal segment (average length 105 mm). The pathologic changes of the PFA were also documented: It was classified as "normal" if the diameter was more than 4 mm at the ostium, and as "small" if the diameter was less than 4 mm. If there were significant calcifications with stenosis of more than 50% of the lumen or segmental occlusions of <10 mm, the PFA was classified as "diseased." Given these classifications, the PFA was patent in all 56 operating sites. Results are shown in Table IV. We could not find statistically relevant differences between the SFA patent and the SFA occluded group concerning the PFA status. The patients were divided into two groups by preoperative patency of the superficial femoral artery: SFA patent and SFA occluded. Duplex ultrasound examinations of the vascular reconstruction were done in all patients preoperatively and during the first five postoperative days. There was no difference between the pre- and postoperative patency status of SFA or PFA.

All intraoperative wound swaps and cultures of graft specimen were reviewed and the microbial spectrum was documented in Table III. We lost two flaps in the SFA occluded group (6%): one due to ischemia (PFA status: normal), probably as a result of extensive lateral mobilization and division of the two uppermost segmental pedicles. The necrotic flap was resected 6 days after the first flap procedure and a rectus femoris muscle flap was done. A second flap was lost due to persistent wound infection with multi-resistant bacteria (extended spectrum β-lactamase, ESBL; PFA status: small). The necrotic part of the flap was resected and a rectus femoris muscle flap was done. Both wound were treated with VAC dressings and closed with skin grafts. The vascular reconstruction could be preserved only in the first case (Tables V and VI). At a median follow-up of 6.4 months, 54 viable flaps could be documented (96.5% success rate). All flaps in the SFA patent group were viable (100%). In the SFA occluded group, 94% of the sartorius flaps were viable (P = .513). In the two patients with sartorius flap loss, the rectus femoris flap was vital.

Table IV. Femoral artery status

	SFA patent N = 23	*SFA occluded N = 33*	P
SFA-status			
Patent	23		
Complete occlusion		29	
Proximal patent (median 105 mm)		4	
PFA-status			
Normal (>4 mm)	16	17	.966
Small (≤4 mm)	0	7	
Diseased			
Calcified, segmental stenosis	4	7	.875
Segmental occlusion	3	2	

PFA, Profundal femoral artery; *SFA*, superficial femoral artery.

Table V. Outcome and follow-up

	SFA patent	*SFA occluded*	*All*	P
Follow-up (months) mean	5.8	6.6	6.4	1.000
Flap loss	0	2 (6.0%)	2 (3.5%)	.513
Infection new/ recurrent	1/2 (13%)	2/2 (12%)	3/4 (12.5%)	1.000
Loss of reconstruction	2 (9%)	3 (9%)	5 (9%)	1.000
Persistent lymphorrhea	0	0	0	1.000
Limb salvage	23 (100%)	29 (88%)	52 (93%)	.891

SFA, Superficial femoral artery.

In three of 13 operating sites that received the flap procedure for a graft at risk, an early prosthetic graft infection could be detected during the postoperative course (23%). In four of 34 patients operated for infected grafts, the infection reappeared within three months postoperatively (11%). In these four cases the infected prosthetic graft had been replaced by an autologous vein graft. The new or recurrent infection led to a loss of the initial vascular reconstruction in five of these seven patients. There were no significant differences between the SFA patent and SFA occluded group (Table II). Microbiology of new and recurrent infections is shown in Table III. Two patients operated for severe graft infections died during the immediate postoperative period from septic multi-organ failure (3% 30-day mortality). Within the median follow-up time of 6.4 months, no further deaths occurred.

Calcitrant lymphorrhea was the indication for the flap procedure in nine patients (four SFA patent, five SFA occluded). In two patients of the SFA patent group lymphorrhea persisted for further 5 days after the flap procedure. Then, the drains could be removed. Follow-up did not show any persistent fluid collections around the vascular structures or the flap (Table II).

DISCUSSION

The use of the proximal sartorius muscle transposition flap as biologic protection procedure in the groin has been widely described and is part of the standard surgical techniques to treat infectious complications in the groin.[1-3,6,7] In our study, the indication for the flap procedure was graft infection (61%), graft at risk (23%), and calcitrant lymphorrhea (16%). In the majority of patients, a simultaneous vascular procedure was necessary (autologous in 61%, bovine/prosthetic in 18%). These data are reflected in the patient populations of several recent publications.[3,8,9]

Microbial spectrum of surgical site infections is similar to other reports in the literature[6] (Table III).

In the group of patients operated for prosthetic graft infections, early mortality rate of 6% (2/34 patients) and rate of recurrent infections with 12% (4/34 patients) are similar to the results reported in the literature.[5] Especially patients with multi-resistant bacteria and patients under immunosuppressive therapy are prone to recurrent infections.[10,11] Our microbiologic data show that in recurrent infection cases, increased bacterial resistance (*E. coli* ESBL and *E. faecium*) as well as fungal infections may have played a relevant role. Therefore, the need for accurate perioperative microbiologic testing, including wound swaps and graft specimen, has to be accentuated. In our opinion, in patients with suspected or proven surgical site infections calculated antibiotic therapy should be started not before obtaining graft specimen and wound swaps intraoperatively, whenever the patient's medical condition allows to. Nevertheless, an excellent limb-salvage rate of 93% was achieved.

The new infections that occurred in two patients with prosthetic grafts at risk (unilateral in one and bilateral in another patient) despite the biologic protection procedure seem to argue for an increased risk of graft infections in certain patient groups (both patients were cachectic and had a history of alcohol abuse), although many risk factors thought to increase wound infections following vascular reconstruction did not predict this complication in several studies.[12,13] It has to be considered that the prophylactic sartorius flap procedure might present a possibly insufficient, but only calming concept to prevent impending prosthetic graft infections. In some patients, it may prove to be only a temporizing measure with an infection appearing at a later date.

The proximal sartorius muscle flap as successful single-intervention therapy in groin lymphatic complications was recently appreciated.[7] Soots and colleagues reported a group of 12 patients that were successfully treated for persistent lymphatic wound drainage after vascular surgery in the groin.[14] In our institution, we use this option, if immobilization, compressive dressings, and local radiotherapy (5 × 1 Gy) did not dry up the lymphorrhea. In nine patients treated by wound revision and sartorius flap procedure, the lymphatic drainage ceased. There were no early or late wound infections.

Regarding the studies that describe the vascular anatomy of the sartorius muscle, arterial blood supply generates from multiple segmental branches of the SFA.[15-19] Mathes and Nahai gave a detailed description of the flap procedure in a standard textbook of plastic and reconstructive surgery.[4] Given these data, vascular surgeons might hesitate to utilize the sartorius muscle as transposition flap in patients with an occluded SFA. In contrast, Ramasastry and coworkers reported a blood supply of the proximal sartorius muscle via branches of the medial and lateral femoral circumflex arteries.[5] They proposed that a patent PFA sufficiently supplies the muscle in the presence of an occluded SFA. These results are supported by our study. We did not find a difference between the SFA patent und the SFA occluded group concerning the flap viability. Obviously, the failing flaps were due to technical mistakes and persistent local infection with multi-resistant bacteria. We are

Table VI. Loss of vascular reconstruction: Case details and management

Patient	*Initial reconstruction*	*Procedure simultaneous with flap*	*Microbiology*	*Loss of reconstruction management*	*Flap status at revision*	*Outcome*
S.W. 75-yo-male	Aorto-bifemoral prosthetic bypass Problem: distal insertion aneurysm left groin	Aneurysm resection and protheto-profundal interpositon with a Dacron graft; Flap indication: graft at risk (kachectic, bad soft tissue coverage, wound healing disturbance after identical procedure at contralateral groin)	*Coagulase-negative Staphylococci*	New prosthetic graft infection Szilagyi 3 with periprothetic abscess (three months after flap procedure) Resection of protheto-profundal interposition graft and protheto-profundal deep-vein bypass	Viable	Follow-up: 26 months Primary patency: 26 months Amputation: no Recurrent infection: no
H.O. 56-yo-male	Aorto-femoral and protheto-popliteal prosthetic bypass Problem: Ischemic rest pain	Initial reconstruction; Flap indication: graft at risk (kachectic, bad soft tissue coverage)	*Enterococci Acinetobacter baumannii*	New prosthetic graft infection Szilagyi 3 with fistula Explantation of all prosthetic material, aorto-femoral deep-vein bypass and femoro-popliteal vein bypass (GSV), primary wound closure	Viable	Follow-up: 6 months Primary patency: 6 months Amputation: no Recurrent infection: no
P.E. 74-yo-male	Femoro-popliteal prosthetic bypass Problem: Ischemic rest pain	Graft explantation and femoro-popliteal vein bypass; Flap indication: prosthetic graft infection Szilagyi 3	*Coagulase-negative Staphylococci Proteus vulgaris Klebsiella oxytoca* (ESBL) *Enterococci; E. coli* (ESBL) Candida albicans	Persistent graft infection Szilagyi 3 with arrosion bleeding, flap necrosis; Partial bypass resection and venous interposition graft, rectus femoris flap	Necrotic	Follow-up: 3 months Primary patency: 3 months Amputation: yes, above knee Recurrent infection: no
S.W. 75-yo-male	Resection of a distal insertion aneurysm and protheto-profundal interpositon with a dacron graft right groin after aorto-bifemoral prosthetic bypass Problem: Wound dehiscence	Debridement; Flap indication: graft at risk	*Coagulase-negative Staphylococci*	New prosthetic graft infection Szilagyi 3 with periprothetic abscess; Resection of protheto-profundal interposition graft and protheto-profundal deep-vein bypass	Viable	Follow-up: 30 months Primary patency: 30 months Amputation: no Recurrent infection: no
L.B. 87-yo-female	Thrombembolectomy CFA and PFA with bovine patch Problem: Early bovine graft infection	Resection of bovine patch, venous patch; Flap indication: bovine graft infection Szilagyi 3	*Staphylococcus aureus*	Recurrent graft infection Szilagyi 3 with arrosion bleeding; Resection of venous patch, femoro-femoral venous interposition graft	Viable	Follow-up: 7 months Primary patency: 7 months Amputation: no Recurrent infection: no

aware of the limitations of this study due to the small study group and the retrospective design. We believe that a proximal sartorius muscle transposition flap is feasible in vascular surgery patients even with an occluded SFA. It is a simple and safe procedure to improve local wound conditions and to promote integration of vascular grafts in infected fields.

CONCLUSIONS

Our data support the concept of biologic protection procedures in vascular surgery. With the sartorius muscle flap as part of a complex surgical management of infectious complications of vascular procedures in the groin, we can achieve excellent limb salvage rates with a low incidence of

reinfection. The concept of prophylactic biologic protection procedures in grafts at risk has to be the object of further clinical investigations. The sartorius muscle transposition flap may be a valuable option in the treatment of calcitrant lymphorrhea in the groin after vascular procedures. Our findings suggest that the patency of the SFA has no influence on the viability of the sartorius muscle flap, wound healing, and limb salvage rate.

The authors thank Ms Katrin Wurdinger for her help in preparing the manuscript.

AUTHOR CONTRIBUTIONS

Conception and design: IT
Analysis and interpretation: IT, CU
Data collection: CU, TB
Writing the article: IT
Critical revision of the article: IT, CU, TB, MS
Final approval of the article: IT, MS
Statistical analysis: CU, TB
Obtained funding: Not applicable
Overall responsibility: IT

REFERENCES

1. Armstrong PA, Back MR, Bandyk DF, Johnson BL, Shames ML. Selective application of sartorius muscle flaps and aggressive staged surgical debridement can influence long-term outcomes of complex prosthetic graft infections. J Vasc Surg 2007;46:71-8.
2. Colwell AS, Donaldson MC, Belkin M, Orgill DP. Management of early groin vascular bypass graft infections with sartorius and rectus femoris flaps. Ann Plast Surg 2004;52:49-53.
3. Landry GJ, Carlson JR, Liem TK, Mitchell EL, Edwards JM, Moneta GL, et al. Muscle flap: an important adjunct for complicated femoral wounds involving vascular grafts. Am J Surg 2009;197:655-9; Discussion:659.
4. Mathes SJ, Nahai F. Reconstructive surgery: principles, anatomy and techniques. New York: Churchill Livingstone Inc; 1997.
5. Ramasastry SS, Liang MD, Hurwitz DJ. Surgical management of difficult wounds of the groin. Surg Gynecol Obstet 1989;169:418-22.
6. Homer-Vanniasinkam S. Surgical site and vascular infections: treatment and prophylaxis. Int J Infect Dis 2007;11;(Suppl 1):S17-22.
7. Shermak MA, Yee K, Wong L, Jones CE, Wong J. Surgical management of groin lymphatic complications after arterial bypass surgery. Plast Reconstr Surg 2005;115:1954-62.
8. Schutzer R, Hingorani A, Ascher E, Markevich N, Kallakuri S, Jacob T. Early transposition of the sartorius muscle for exposed patent infrainguinal bypass grafts. Vasc Endovasc Surg 2005;39:159-62.
9. Pu LL, Jahania MS, Mentzer RMJ. Successful management of recalcitrant groin lymphorrhoea with the combination of intraoperative lymphatic mapping and muscle flap. J Plast Reconstr Aesthet Surg 2006; 59:1363-6.
10. Wipke-Tevis DD. Vascular infections: medical and surgical therapies. J Cardiovasc Nurs 1999;13:70-81.
11. Kaufman JL, Shah DM, Corson JD, Skudder PA, Leather RP. Sartorius muscle coverage for the treatment of complicated vascular surgical wounds. J Cardiovasc Surg (Torino) 1989;30:479-83.
12. Chang JK, Calligaro KD, Ryan S, Ruyan D, Dougherty MJ, Stern JJ. Risk factors associated with infection of lower extremity revascularisation: analysis of 365 procedures performed at a teaching hospital. Ann Vasc Surg 2003;17:91-6.
13. Radine C, Koscielny A, Hirner A, Verrel F. Inguinale Wundkomplikationen nach gefäßchirurgischen Eingriffen—eine prospektive Studie zur Evaluation prädisponierender Faktoren. Gefäßchirurgie. 2010;15: 406.
14. Soots G, Mikati A, Warembourg HJ, Watel A, Noblet D. Treatment of lymphorrhea with exposed or infected vascular prosthetic grafts in the groin using sartorius myoplasty. J Cardiovasc Surg (Torino) 1988;29: 42-5.
15. Habermeyer P, Kaiser E, Mandelkow H, Schweiberer L, Stock W. [Anatomy and clinical aspects of sartoriusplasty]. Handchir Mikrochir Plast Chir 1987;19:21-2.
16. Kaiser E, Genz KS, Habermeyer P, Mandelkow H. [Arterial supply of the Sartorius muscle]. Chirurg 1984;55:731-2.
17. Tanaka C, Ide MR, Junior AJ. Anatomical contribution to the surgical construction of the sartorius muscle flap. Surg Radiol Anat 2006;28: 277-83.
18. Wu LC, Djohan RS, Liu TS, Chao AH, Lohman RF, Song DH. Proximal vascular pedicle preservation for sartorius muscle flap transposition. Plast Reconstr Surg 2006;117:253-8.
19. Yang D, Morris SF, Sigurdson L. The sartorius muscle: anatomic considerations for reconstructive surgeons. Surg Radiol Anat 1998;20: 307-10.

Submitted Sep 23, 2010; accepted Nov 4, 2010.