### **Original Research Article**

DOI: http://dx.doi.org/10.18203/2349-2902.isj20172577

# Protection of femoral vessels and vascular grafts after inguinal lymphadenectomy or femoral bypass by using prophylactic routine sartorius muscle flap shield coverage

#### Ahmed Fawzy, Ahmed Gaber\*, Hesham Abugruidah, Ahmed El Kased

Department of General Surgery, Faculty of Medicine, Al Menofia University, Egypt

Received: 15 May 2017 Accepted: 29 May 2017

## \*Correspondence: Dr. Ahmed Gaber,

E-mail: ahmed.eltatawy@med.menofia.edu.eg

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

#### **ABSTRACT**

**Background:** Groin vascular infections are potentially catastrophic situations as limb loss or even death may occur in a high percentage of patients. A growing evidence support the benefit of muscle flap covering for these non-healing or infected wounds with stressing on their increased efficacy when used prophylactically. Sartorius muscle flap is granted here by its anatomical characteristics.

**Methods:** Fifty Sartorius muscle flaps were done for 39 patients. Flaps were done routinely on prophylactic basis for protection of native femoral vessels or vascular grafts either for oncological or vascular causes in conjunction with inguinal lymphadenectomy or femoral bypass graft. Great care was taken to preserve the first segmental branch to the muscle and avoided its injury.

**Results:** Prophylactic Sartorius muscle flap was done for oncological causes in 46% while for vascular causes in 54% of total flap number. The operative time ranged from 14-20 minutes for every flap with mean 16 minutes with negligible blood loss and no any donor site morbidity. The complication rate was 26%, including mild skin infection 12%, seroma 6%, partial superficial skin necrosis 6%, and hematoma 2%.

**Conclusions:** Sartorius muscle flap has versatile benefits. Its role has been proved as a shield protecting and covering the femoral vessels or vascular grafts and resulted in decreased rate of overall complications. We recommend prophylactic Sartorius muscle flap coverage on routine basis considering it the workhorse of efforts done to vascular protection.

Keywords: Femoral vascular grafts, Inguinal lymphadenectomy, Sartorius muscle flap

#### INTRODUCTION

Complex groin wounds pose a serious challenge to patients and their caregivers as well. <sup>1</sup> It ranges from mild wound infections or dehiscence to draining wounds or sinuses, up to active infections with exposed or grossly infected vessels or grafts. There may be catastrophic haemorrhage if vein graft is infected with gram negative organisms. <sup>1-3</sup> The groin ranks as the commonest site for vascular infections because of its proximity to the perineum, the relatively superficial lie of the native

vessels or graft, undermining skin edges in arterially compromised patients and high chance of cutting of lymphatic channels during dissection.<sup>3</sup>

Inguinal lymphadenectomy has an incontrovertible value in both cure and survival in managing of primary epithelial cancers and/or melanomas arising from vulva, vagina, urethra, penis, scrotum, anorectum in addition to lower extremities.<sup>4</sup> Groin dissection unfortunately, has been associated with significant complications like wound infection, seroma and skin necrosis, therefore

wound dehiscence and lymphedema. With up to 85% of published complications rate the most common is skin edge necrosis occurring in 7.5-62 % of dissections.<sup>5,6</sup>

The poor healing following groin dissection is mostly due to poor vascularity of the lower flap. The blood supply of the skin of the groin is all cut during groin dissection. Also, the large dead spaces in the femoral triangle, bacteria that may be present within the lymph nodes, and thin skin flaps are omit important contributing factors.<sup>6</sup>

Several attempts done to minimize the morbidity of groin wounds by employing well vascularized flaps of adequate bulk to obliterate the dead space promoting wound healing. Flap closure have many advantages as it brings well vascularized tissue from a distant area to the groin therefore pre-operative and post-operative radiation therapy can be given safely. Also, it covers the dead space in the femoral triangle decreasing the chance for seroma formation. It aids in tensionless wound closure shortening the post-operative hospital stay. The commonly used flaps are the Sartorius, tensor fascia lata, rectus abdominis, rectus femoris, gracilis, anterolateral thigh flap and abdominal flaps.

Baronofosky in 1948 was the first to describe Sartorius muscle flap transposition to protect vessels after inguinal lymphadenectomy. Since then, the Sartorius muscle transposition flap was applied to manage a variety of complex groin wounds to guard against wound breakdown after lymphadenectomy, to overcome persistent lymphatic leaks, and for treating exposed and/or infected femoral vessels and grafts after vascular intervention. In 1980 Méndez Fernández and his colleagues reported that Sartorius muscle flap showed a great success in the management of vascular groin infections.

Sartorius muscle is a long, thin, flat and superficial muscle extending from the anterior superior iliac spine (ASIS) diagonally across the thigh to the medial tibial condyle. It has a type IV (segmental) pattern of circulation. Its vascular supply is significant in that, it has six to seven and may reach up to 11 segmental branches from the superficial femoral vessels. They course to the medial edge of the muscle and enter the muscle belly on the posterior surface. 6,10

The Sartorius muscle flap has many precious characteristics over other muscle flaps. It is expendable and immediately adjacent to the groin, easy to be dissected, and its harvest does not cause functional deficit. Unfortunately, despite these advantages, its reliability is questioned because of its segmental blood supply and limited arc of rotation. 6,10

#### **METHODS**

During the period from July 2011 to January 2017, a prospective study was performed over 39 patients in Al

Menoufia University Hospitals. Fifty Sartorius muscle flap were done to cover the femoral vessels or vascular grafts after inguinal lymphadenectomy or femoral bypass. Patients underwent the surgery under general or epidural anesthesia or both after obtaining their consent, complete clinical examination, imaging and laboratory investigations. All patients received prophylactic antibiotics one hour preoperatively and deep venous thrombosis prophylaxis in the form of elastic stocking, early ambulation and low molecular weight heparin 40 I.U. / 12 hours. Co-morbidities e.g. hypertension, D.M., COPD were recorded. Twenty-seven flaps were done for vascular causes over twenty patients as the flap was done bilaterally in seven patients with aortobifemoral bypass (Figure 1).



Figure 1: Aorto-bifemoral bypass for bilateral lower limb ischemia.



Figure 2: Different patients required inguinal lymphadenectomy. A) Melanoma at the Rt. Heel. B) Melanoma at the Rt. Medial malleolus. C) Radioisotope scanning showing remnant melanoma at Rt. Leg. D) Cancer vulva. E) Advanced cancer vulva with kissing ulcer.

Twenty-three flaps were done after inguinal lymphadenectomy for nineteen patients as groin dissection was done bilaterally in four cases (Figure 2, 3).

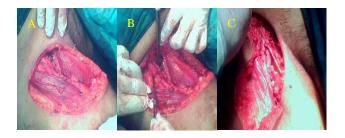


Figure 3: Different inguinal lymphadenectomies. A) Classic inguinal lymphadenectomy. B) Pointing to femoral vessels. C) Lazy S incision for inguinal lymphadenectomy.



Figure 4: Dissection of sartorius muscle.

#### Flap elevation technique

Immediately after completion of the primary procedure the Sartorius flap was elevated (Figure 4). Flap elevation started by dissection of the lateral border of Sartorius muscle towards the anterior superior iliac spine and to less extent the medial border so as not to injure the segmental perforators. Then the muscle was detached from its origin with or without dissection of most upper part of the medial border. The whole lateral and posterior surfaces became totally free. Then the muscle was elevated from proximal to distal until the first vascular pedicle is encountered, usually 5.5 to 7.5 cm from the anterior superior iliac spine (Figure 5).



Figure 5: Identification of first segmental perforator.

It is very important to emphasize here that due to the segmental pattern of blood supply (type IV), the preservation of the first segmental branch and all pedicles are of outmost importance so as not to jeopardize the vascularity of the flap and therefore its necrosis. Then with the vascular pedicle as its pivot point, the upper part of the muscle was transposed or rotated medially to cover the femoral vessels. The muscle then was anchored to the inguinal ligament, adductors and psoas muscles (Figure 6).



Figure 6: Muscle transposition to cover the femoral vessels or vascular grafts.

Lastly the doubtful skin edges from both skin flaps, most likely to have later necrosis, were excised. The wound was closed in layers (Figure 7). In groin dissection operations and occasionally in other cases when needed we have put suction drain that was removed when the daily drained volume was less than 30ml.



Figure 7: Twelve days postoperative after inguinal lymphadenectomy just before stich removal.

#### **RESULTS**

Fifty Sartorius flaps were done for thirty-nine patients where they were 22 males (56.4%) and 17 females (43.6%). Sartorius muscle flap was done bilaterally in 11 patients (28.2%) (Table 1). (Figure 8) The age of patients ranged from 32 to 73 years with mean 54.3 years. The operative time ranged from 14-20 minutes for every flap with mean 16 minutes plus the original time of the primary procedure.

**Table 1: Characteristics of patients.** 

		No.=39	%
	Female	17	44 %
Sex	Male	22	56 %
Risk factors and comorbidities	Malnutrition	13	33.3 %
	Smoking	15	38.5%
	Obesity	14	36 %
	Anemia	11	28.2 %
	Hypertension	21	54 %
	Diabetes	16	41 %
	Chronic chest diseases (COPD)	6	15.3 %
Primary Lesion	Chronic bilateral lower limb ischemia	7	18%
	Chronic unilateral lower limb ischemia	10	25.6 %
	Femoral artery aneurysm	1	2.5%
	Big groin abscess	1	2.5 %
	Gun shots to groin	1	2.5 %
	Cancer vulva	8	20.5 %
	Squamous cell carcinoma of the ipsilateral lower limb	5	12.8%
	Melanoma of the ipsilateral lower limb	4	10.25 %
	Low anal canal carcinoma	1	2.5 %
	Soft tissue sarcoma of groin	1	2.5 %

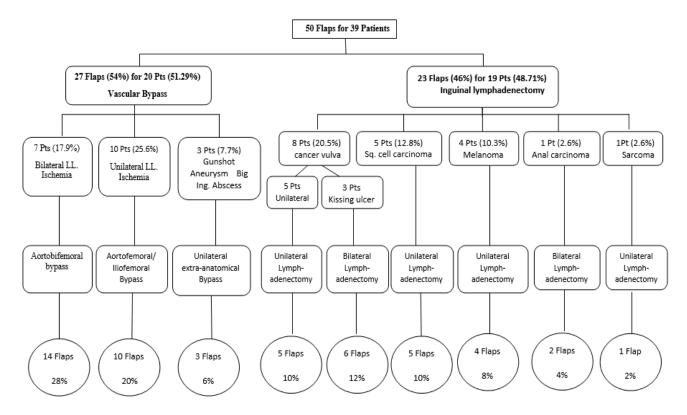


Figure 8: Muscle flap.

The blood loss due to the flap procedure was very little and no patient required blood transfusion due to the flap procedure, despite the need for blood transfusion at least 1 unit in many patients but due to the primary procedure. The hospital means stay ranged from 7-11 days with mean 8.3 days and the follow up period ranged from 3-48

months. Regarding post-operative complications, the total complication rate was 26% where only six flaps (12 %) showed mild superficial wound infection which responded fairly to short course systemic and local antibiotics with no need to major debridement. Three post lymphadenectomy flaps (6%) showed mild seroma which

resolved rapidly with cautious aspiration. Partial superficial skin edge necrosis occurred after lymphadenectomy to three flaps (6 %) which responded fairly to repeated dressing with very minor debridement. One flap (2%) had subcutaneous hematoma which occurred after accidentally fall of the subcutaneous drain and reintroduction of new sterile drain was done in the operative theatre after hematoma evacuation (Table 2).

Table 2: Post-operative morbidity and mortality.

	N=50	%
Mild superficial wound infection	6	12 %
Seroma	3	6 %
Partial superficial skin edge necrosis	3	6 %
Hematoma	1	2 %
Mortality	0	0 %

There was fare wound healing with no any deep wound infection, vascular or graft related infection. Regarding the donor site morbidity, no affection of flexion power of hip or knee joints reported by any patient during period of follow up. No major flap loss and no mortalities had occurred in post-operative period.

#### **DISCUSSION**

Vascular complications due to groin surgeries can lead to catastrophic outcomes and pose a great healthcare burden and cost. Complex groin wounds are prone to myriad complications, from superficial cellulitis, up to limb loss, septicaemia, pulmonary embolism or even death. The reported incidence of early post-operative wound complications varies strongly in the literature. Lymphedema of the leg and/or the genital area may occur in varying degrees. These may be attributed mainly to the potentially contaminated groin area, division of the blood supply to the skin flaps, interruption of collateral lymphatics and the presence of a large dead space in the femoral triangle giving chance for serous or lymphatic collection. <sup>7,12-15</sup>

In the previous era, the treatment of groin infected grafts was total excision of the graft with massive debridement and extra- anatomical bypass. Limb loss and mortality rates were reported as 10% - 79% and 9% - 58%, respectively. Many of new researches suggest early initiation of targeted anti-microbial therapy and debridement, in conjunction with coverage of the femoral vessels by viable muscle flap, can help in achieving graft and limb salvage. The proposition of the Sartorius muscle for exposed patent infra-inguinal bypass grafts describing it as the viable alternative in the armament of the surgeons. The proposition of the surgeons.

Financial wise, all these actions quickly translate into healthcare costs. The added cost of surgical site infections has been estimated to be between \$3648 and

\$6830 per patient and may reach \$13000 or more according to the degree of morbidity, reconstruction done, and length of hospital stay.<sup>2,12,21</sup>

In a trial to decrease these risks, complications, bill of service, there is a growing trend for prophylactic muscle flaps with evidence that it reduces complications and need for salvage operations. <sup>12</sup> Gravvanis A et al and Fischer JP et al frequently utilized the Sartorius muscle flap for groin prophylaxis. <sup>2,7,12,17,22</sup> This match with our point of view on which this study was designed based on the principle of prophylaxis is better than treatment. We believe that it will decrease the morbidity and the bill for medical service.

Many authors agreed with our choice of the Sartorius muscle which is well-suited granted by its proximity, reliable and minimal donor-site morbidity giving it a versatile benefit in this aspect. 2,3,6,7,10-12,16-,20-26

Fifty Sartorius muscle flaps were done in this study. The age of patients ranged from 32 to 73 years with mean 54.3 years this matches with Gravvanis A et al who worked on 46 patients with ages ranged from 47 to 71 years with the mean age 52 years.<sup>7</sup>

During dissection, the first segmental branch entering the Sartorius muscle was usually found at 5.5 to 7.5 cm from the anterior superior iliac spine this matches with results of Gravvanis A et al who described it at distance 5-7 cm, Landry GJ et al who described it at distance about 6.5 cm. Wu LC et al, in her study over 20 cadavers and 19 patients, documented that in the patients the mean distance was 6.2 cm (range, 5.5 to 7.5 cm). <sup>7,10,19</sup> While in the cadavers, it was 6.6 cm (range, 5 to 9.5cm). Lastly Mojallal A et al on thirty cadavers demonstrated that the first pedicle was present at 6.86 cm with range 4.1 to 9.6 cm. <sup>26</sup>

The comorbidities in present study were hypertension 54%, vascular problems 51.3%, malignancy 48.7%, D.M 41%, smoking 38.5%, obesity 36%, malnutrition in 33.3%, anemia 28.2% and COPD 15.3%. This match most authors for example John P. Fischer et al who mentioned that the comorbidities for patients undergoing prophylactic flaps as hypertension 83.8%, D.M 45.6%, obesity 36.8%, smoking 35.3%, COPD 25%. 12

The overall postoperative complication rate was 26% with 12% mild superficial wound infection, 6% seroma, 6% partial superficial skin edge necrosis and 2% hematoma. Both seroma and partial superficial skin edge necrosis occurred in patients of lymphadenectomy. This comparable to Gravvanis A et al results which showed wound infection, in the form of cellulitis in 7.5%, superficial skin edge necrosis, which didn't require debridement in 5% of patients. Fischer JP et al in their studies showed higher or equal complication rate with control groups and less complication rate when used prophylactic muscle flaps. 12,17 The explanation of this

may be as in present study the patients were composite of vascular causes and post inguinal lymphadenectomy patients. The latter which by nature have higher complication rate that raised the total overall rates compared to Fischer JP et al who worked on vascular causes only. 12,17 This is supported by the higher rate of complications of Faut M et al who worked over lymphadenectomy patients without prophylactic flaps, they described on 244 lymphadenectomy patients the overall complication rate was 51.2 % with wound infection 29.8 %, seroma 21.5 %, skin necrosis 13.6 %, and hematoma 5 %.14 Therefore and based upon these results, we can document that the use of prophylactic Sartorius muscle flap decreased the overall complication rate especially the post-operative infection, wound dehiscence and seroma rate. This is supported by many authors. <sup>2,3,7,10-12,16-20,22-26</sup> Moreover Wu LC et al stated that well-vascularized muscle can deliver increased levels of oxygen, nutrients and antibiotics, as well as it conform and fill defects. 10 This is supported by Calderon W et al in their study on dogs, who stated that the bacterial count was significantly higher in fasciocutaneous flaps than muscular or musculocutaneous flaps with increased levels of the collagen and hydroxyproline inside the wound.<sup>27</sup> Twine CP et al documented that the muscle flap has an evidence that it increases the local antimicrobial and anti-phagocytic activity which is beneficial in prevention of secondary infection.<sup>25</sup> It also decreases the amount of serous fluid and lymphatic fistulas in the groin.

Contrary to our results Stuiver MM et al stated that Sartorius muscle transposition flap may increase the rate of complications especially seroma and persisting lymphedema in vulvar cancer patients.<sup>13</sup>

Some authors may prefer using the rectus femoris muscle flap if the dead space is large for its bigger bulk. 1,12,17,28 Chatterjee A et al reported that the rectus femoris muscle flap is more cost effective when used to treat the infected vascular groin graft wound.<sup>29</sup> Ryu DY et al mentioned that Sartorius muscle flap lacks bulk and has a limited arc rotation, making it suboptimal for large wounds, in comparison to rectus femoris muscle flap, but the rectus femoris muscle flap needs a longer separate incision in the thigh.<sup>16</sup> They stated also that due to the segmental blood supply arising from superficial femoral artery, some vascular surgeons might hesitate to use the Sartorius muscle flap in patients with an occluded superficial femoral artery. Lastly despite this they concluded that the use of Sartorius muscle flap is recommended to treat groin wound infection, including lymphoceles.

Our results showed that the operative time ranged from 14-20 minutes for each flap with mean 16 minutes with negligible blood loss and no any donor site morbidity this agrees with Gravvanis A et al who stated that it has a negligible donor site morbidity and insignificant additional operative time.<sup>7</sup>

The hospital stays in present study ranged from 7-11 days with mean 8.3 days compared to 8 and 13,3 days with Gravvanis A et al and Fischer JP et al respectively.<sup>7,12</sup>

#### **CONCLUSION**

Present results documented that Sartorius muscle flap has versatile benefits as it is exceptionally well-suited and granted by its proximity that makes it easily performed through the same groin incision. It is safe, reliable, minimal risk and done in negligible time with minimal donor site morbidity. Prophylactic Sartorius muscle flap proved its role acting as a shield protecting and covering the femoral vessels or vascular grafts after inguinal lymphadenectomy or femoral bypass and resulted in decreased rate of overall complications especially infection, seroma, skin necrosis with no any deep wound infection or infected graft. We recommend prophylactic Sartorius muscle flap coverage on routine basis considering it the workhorse of efforts done to guard against complications and vascular protection.

Funding: No funding sources Conflict of interest: None declared Ethical approval: The study was approved by the institutional ethics committee

#### REFERENCES

- 1. Alkon JD, Smith A, Losee JE, Illig KA, Green RM, Serletti JM. Management of complex groin wounds: preferred use of the rectus femoris muscle Flap. Plast Reconstr Surg. 2005;115(3):776-83.
- Fischer JP, Nelson JA, Shang EK, Wink JD, Wingate NA, Woo EY, et al. Predicting the need for muscle flap salvage after open groin vascular procedures: a clinical assessment tool. J Plast Surg Hand Surg. 2014;48:389-95.
- 3. Williams IM, Milling MA, Shandall AA. Vascularised muscular flaps and arterial graft infection in the groin. Eu J vasc endovas surg. 2003;25(5):390-5.
- 4. Alsisi AE, Al batanony AA, El-Saka D, Fawzy A. Immediate closure of groin wounds after inguinal lymphadenectomy using anterolateral thigh flap for the at-risk skin. Kasr El Aini J Surg. 2014;15(1):99-104.
- 5. El Kased AF. Use of inferiorly based rectus abdominis myocutaneous flap for reconstruction of large groin defects following tumour resection. Sc J Az Med Fac. 2002;23(2):741-57.
- 6. Gupta AK, Kingsly PM, Jeeth IJ, Dhanraj P. Groin reconstruction after inguinal block dissection. In J urol. 2006;22(4):355-9.
- 7. Gravvanis A, Caulfield RH, Mathur B, Ramakrishnan V. Management of inguinal lymphadenopathy immediate sartorius transposition and reconstruction of recurrence with pedicled ALT Flap. Ann Plast Surg. 2009;63(3):307-10.

- 8. Ravi R. Morbidity following Groin Dissection for Penile Carcinoma. British J Urol. 1993;12:941-5.
- Baronofsky ID. Technique of inguinal node dissection. Surg. 1948;24:555-65.
- Wu LC, Djohan RS, Liu TS, Chao AH, Lohman RF Song DH. Proximal vascular pedicle preservation for sartorius muscle flap transposition. Proximal vascular pedicle preservation. Plast Reconstr surg. 2006;117(1):253-8.
- Méndezfernández MA, Quast DC, Geis RC, Henly WS. Distally based sartorius muscle flap in the treatment of infected femoral arterial prostheses. J Cardiovasc Surg. (Torino) 1980;21:628-31.
- 12. Fischer JP, Nelson JA, Mirzabeigi MN, Wang GJ, Foley PJ, Wu LC, et al. Prophylactic muscle flaps in vascular surgery. Vasc Surg. 2012;55:1081-6.
- Stuiver MM, Djajadiningrat RS, Graafland NM, Vincent AD, Lucas C, Horenblas S. Early wound complications after inguinal lymphadenectomy in Penile Cancer: a historical cohort study and riskfactor analysis. Eur Urol. 2013;64(3):486-92.
- 14. Faut M, Heidema RM, Hoekstra HJ, van Ginkel RJ, Been SL, Kruijff S, et al. Morbidity after inguinal lymph node dissections: it is time for a Change. Ann Surgic Oncol. 2017;24(2):330-9.
- Gopman JM, Djajadiningrat RS, Baumgarten AS, Espiritu PN, Horenblas S, Zhu Y, et al. Predicting postoperative complications of inguinal lymph node dissection for penile cancer in an international multicentre cohort. BJU Int. 2015;116:196-201.
- 16. Ryu DY, Jung HJ, Ramaiah VG, Rodriguez-Lopez JA, Lee SS. Infected groin (graft/patch): managed with sartorious muscle flap. Vasc Spec Int. 2016;32(1):11-16.
- 17. Fischer JP, Mirzabeigi MN, Sieber BA, Nelson JA, Wu LC, Kovach SJ, et al. Outcome analysis of 244 consecutive flaps for managing complex groin wounds. J Plast Reconstr Aesthetic Surg. 2013;66:1396-404.
- 18. Khalil IM, Sudarsky L. Sartorius muscle "twist" rotation flap: an answer to flap necrosis. JVS. 1987;6(1):93-4.
- 19. 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. Am J Surg. 2009;197(5):655-9.
- 20. 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(2):159-62
- 21. Menzin J, Marton JP, Meyers JL, Carson RT, Rothermel CD, Friedman M. Inpatient treatment patterns, outcomes, and costs of skin and skin structure infections because of staphylococcus aureus. Am J Infect Contr. 2010;38:44-9.
- 22. Fischer JP, Nelson JA, Rohrbach JI, Wu LC, Woo EY, Kovach SJ, et al. Prophylactic muscle flaps in vascular surgery: the penn groin assessment scale Plast Reconstr Surg. 2012;129:940e-9e.
- 23. Kotb H. Lower extremity vascular prosthesis infection successful salvage with local muscular flap reconstruction. Bull Alex Fac Med. 2008;44(1):173-8.
- Perez-Burkhardt JL, Gonzalez-Fajardo JA, Carpintero LA, Mateo AM. Sartorius myoplasty for the treatment of infected groins with vascular grafts. J Cardiovasc Surg. 1995;36(6):581-5.
- 25. Twine CP, Lane IF, Williams IM. Management of lymphatic fistulas after arterial reconstruction in the groin. Ann vasc surg. 2013;27(8):1207-15.
- Mojallal A, Wong C, Shipkov C, Hocuoq C, Recchiuto J, Brown S, et al. Redefining the Vascular Anatomy and Clinical Applications of the Sartorius Muscle and Myocutaneous Flap. Plast Reconstr Surg. 2011;127(5):1946-57.
- 27. Calderon W, Chang N, Mathes SJ. Comparison of the effect of bacterial inoculation in musculocutaneous and fasciocutaneous flaps. Plast Reconstr Surg. 1986;77:785.
- 28. Silvestre L, Pedro LM, e Fernandes RF, Silva E, e Fernandes JF. Rectus femoris muscle flap based on proximal insertion mobilization to cover a groin infected vascular graft. J vasc surg. 2015;62(4):1064-7.
- Chatterjee A, Kosowski T, Pyfer B, Fisher CS, Tchou JC, Maddali S. A cost-utility analysis comparing the sartorius versus the rectus femoris flap in the treatment of the infected vascular groin graft wound. Plast Reconstr surg. 2015;135(6):1707-14.

Cite this article as: Fawzy A, Gaber A, Abugruidah H, El Kased A. Protection of femoral vessels and vascular grafts after inguinal lymphadenectomy or femoral bypass by using prophylactic routine sartorius muscle flap shield coverage. Int Surg J 2017;4:2157-63.