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

INTRODUCTION

Complex groin wounds pose a serious challenge to patients and their caregivers as well. 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. 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.

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. 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.\textsuperscript{5,6}

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.\textsuperscript{5,6}

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.\textsuperscript{7} 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.\textsuperscript{8} The commonly used flaps are the Sartorius, tensor fascia lata, rectus abdominis, rectus femoris, gracilis, anterolateral thigh flap and abdominal flaps.\textsuperscript{6}

Baronofsky in 1948 was the first to describe Sartorius muscle flap transposition to protect vessels after inguinal lymphadenectomy.\textsuperscript{9} 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.\textsuperscript{8,10} In 1980 Méndez Fernández and his colleagues reported that Sartorius muscle flap showed a great success in the management of vascular groin infections.\textsuperscript{11}

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.\textsuperscript{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.\textsuperscript{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.](image)

![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.](image)
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).

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).

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.

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). 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.

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

Figure 4: Dissection of sartorius muscle.

Figure 5: Identification of first segmental perforator.

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

Figure 7: Twelve days postoperative after inguinal lymphadenectomy just before stich removal.
### Table 1: Characteristics of patients.

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

### 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>
<thead>
<tr>
<th>Table 2: Post-operative morbidity and mortality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=50</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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.7,12,15

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.16 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.15,19 In 2005 Schutzer R et al recommended the early transposition of the Sartorius muscle for exposed patent infra-inguinal bypass grafts describing it as the viable alternative in the armament of the surgeons.20

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.2,12,21

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.15 Gravvanis A et al and Fischer JP et al frequently utilized the Sartorius muscle flap for groin prophylaxis.7,12,17,22 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.7,3,6,7,10-12,16,20-26

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.7

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).7,10,19 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.26

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.7 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.1,2,3,7,10-12,16,20,22,26 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.27 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.23 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.13

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.29 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.16 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.7 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.7,12

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
