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# Lymphatic complications after vascular interventions

**Andrzej Obara[1], Miroslaw A. Dziekiewicz[1], Marek Maruszynski[1], Adam Witkowski[2], Maciej Dąbrowski[2], Zbigniew Chmielak[2]**

[1]Department of Vascular and Endovascular Surgery, Military Institute of Medicine, Warsaw, Poland
[2]Department of Interventional Cardiology and Angiology, Institute of Cardiology, Warsaw, Poland

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**Abstract**

***Introduction:*** *Lymphorrhea due to classical and mini-invasive surgical interventions on femoral and popliteal arteries is a serious hindrance to patient treatment. Depending on the experience of a particular center, the incidence and frequency of this type of complication may constitute a serious clinical problem. While the level of lymphorrhea intensity and its duration result in certain foreseeable consequences, their treatment can be a time-consuming and multistep procedure.*
***Aim:*** *To compare different types of vascular interventions with lymphorrhea occurrence.*
***Material and methods:*** *The authors conducted a retrospective analysis of lymphatic complications based on the material collected between 2005 and 2012 at the Department of Vascular and Endovascular Surgery of the Military Institute of Medicine in Warsaw and in the Department of Interventional Cardiology and Angiology of the Institute of Cardiology in Anin, Warsaw, in 2009–2012.*
***Results:*** *Maintaining due thoroughness when dissecting tissues and treating the cutting line in this area with ligatures and tissue puncture are the most reliable methods of minimizing the risk of lymphatic leakage after surgical procedures performed in a classical way. The lymphatic complication under analysis is far less likely to occur when procedures are performed as planned and an endovascular technique is used – statistical significance $p < 0.05$. Minimally invasive and fully percutaneous procedures performed via needle puncture, including the use of the fascial closure technique to close the femoral artery, eliminate the likelihood of the occurrence of this vascular complication – statistical significance was found with p value less than 0.05.*
***Conclusions:*** *We concluded that in every case by minimizing the vascular approach we protected the patient against lymphatic complications.*

***Key words:*** *lymphatic leakage, vascular prosthetics, access complications.*

## Introduction

Lymphatic complications due to arterial interventions pertain predominantly to all procedures performed on the femoral and popliteal arteries. The incidence rate of this complication is as high as 18% and results in impaired postoperative wound healing, prolonged hospital stay, and *ipso facto* increased cost of treatment [1, 2]. However, lymphatic complications can also occur after procedures in other vascular areas, for instance within the abdominal cavity, thorax and neck [3–6]. The most frequently observed is lymphorrhea of various intensity, which can lead to postoperative wound infection, including its suppuration or abscess formation in this area. As a consequence, an infection of the artificial material used for bypass grafts or vessel reconstruction (e.g.

**Address for correspondence**
Miroslaw A. Dziekiewicz MD, PhD, Department of Vascular and Endovascular Surgery, Military Institute of Medicine, 128 Szaserow St, 04-141 Warsaw, Poland, phone: +48 602 507 028, e-mail: dziekiewicz@wp.pl

a vascular prosthetics or a patch) can occur, which can result in septic bleeding [2], septicemia [7], or multi-organ failure [8] (Table I).

## Aim

The aim of the study was to analyze lymphatic complications after vascular surgery in patients treated at the Department of Vascular and Endovascular Surgery of the Military Institute of Medicine in Warsaw in 2005–2012, and in the Department of Interventional Cardiology and Angiology of the Institute of Cardiology in Anin, Warsaw, in 2009–2012, where aortic valve implantations through femoral access were performed.

## Material and methods

The analysis included 1,580 patients who underwent surgery during this period. The procedures performed involved the following vascular areas: neck, thorax, abdomen, retroperitoneal space, and lower extremities. The sample group consisted of 1,232 (77.9%) men and 348 (22.1%) women. The mean age was 45 years (35–95 years). One hundred and eight transcatheter aortic valve implantation (TAVI) procedures were performed. Three hundred and seventy patients underwent a planned endovascular aneurysm repair (EVAR) procedure due to abdominal aorta aneurysm whereas 42 were operated on due to a ruptured abdominal aorta aneurysm (rAAA). At that time, 51 patients with a thoracic aorta aneurysm underwent a planned thoracic EVAR (TEVAR) procedure and 22 emergency TEVAR procedures. In the latter case, they were traumatic ruptures of the thoracic descending aorta, immediately beneath the point where the left subclavian artery branches off. Moreover, 39 stent graft implantations to the thoracic artery due to acute aorta dissection (AAD) were performed. From the group of patients treated classically due to an abdominal aorta aneurysm (AAA), only those patients who required the implantation of a bifurcated (aortobifemoral) prosthesis were selected, since lymphorrhea was only observed in those patients. This group consisted of 112 patients operated on as planned and 13 patients who underwent emergency surgery due to a ruptured aneurysm. Furthermore, in the period under analysis, 212 patients were surgically treated due to an aortobiiliac occlusion. Another type of surgery was a femoropopliteal bypass graft, which was performed in 136 patients.

**Table I.** Lymphorrhea – a summary overview according to surgical procedure

| Type of surgery | Number of procedures, *n* | Number of lymphatic leakages, *n* | Percentage (in groups) [%] |
|---|---|---|---|
| TAVI | 108 | 2 | 1.8 |
| EVAR (planned) | 370 | 18 | 4.8 |
| EVAR (emergency) | 42 | 5 | 11.9 |
| TEVAR (planned) | 51 | 3 | 5.8 |
| TEVAR (emergency) | 22 | 3 | 13.6 |
| AAD | 39 | 2 | 5.1 |
| Classical AAA | 112 | 5 | 4.4 |
| Classical rAAA | 13 | 2 | 15.4 |
| Aortobifemoral bypass graft | 212 | 13 | 6.1 |
| Femoropopliteal bypass graft | 136 | 15 | 11.02 |
| Femoral artery embolectomy | 166 | 15 | 7.2 |
| Profundoplasty | 111 | 12 | 10.8 |
| Suprapubic vascular graft | 36 | 4 | 11.1 |
| Subclavian artery transposition | 21 | 2 | 9.5 |
| Femoral artery pseudoaneurysm | 83 | 15 | 18.07 |
| Fascial closure | 58* | 0 | 0 |
| **Total number of procedures** | | | **1,580** |

**Fascial closure was performed in 58 patients closing 116 common femoral arteries.*

At the same time, 166 patients required femoral artery embolectomy. Profundoplasty was performed in 111 patients. A suprapubic vascular graft was suggested to 36 patients. Twenty-one procedures of subclavian artery transposition were performed in patients with subclavian steal syndrome. Another examined group was made up of patients with femoral artery pseudoaneurysms. This group consisted of 83 patients. The last group comprised patients in whom fully percutaneous stent-graft implantations due to an abdominal or thoracic aorta aneurysm were performed. Thus, the femoral artery was closed by performing fascial closure. This group consisted of 58 patients in whom homeostasis was achieved after bilateral removal of stent-graft implantation sets in the manner mentioned above. In this way, 116 common femoral arteries were closed.

After 94–240 h, lymphatic leakage occurred in all patients and persisted from 7 to 24 days. Lymphatic leakage was reported in 2 patients (1.8%) after TAVI, 18 (4.8%) after planned EVAR procedures, 5 (11.9%) after emergency EVAR procedures, 3 (5.8%) after planned TEVAR procedures and 3 (13.6%) after emergency TEVAR procedures. Following endovascular treatment of acute thoracic aorta dissection, lymphatic leakage occurred in 2 patients (5.1%). In patients on whom open AAA surgery was carried out, 5 (4.4%) cases of lymphorrhea were observed – and 2 (15.4%) in those operated on due to rAAA. In the group of patients with aortobiiliac occlusion, after performing aortobifemoral (bypass) graft surgery, 13 (6.1%) cases of lymphatic leakage were reported. Another group was made up of patients who underwent femoropopliteal bypass graft surgery, in which 15 (11.02%) cases of lymphatic leakage were detected. In 2 patients from this group, the leakage occurred in the wound in the popliteal fossa. Fifteen (7.2%) cases of lymphorrhea were observed after femoral artery embolectomy, 12 (10.8%) after profundoplasty, and 4 (11.1%) after a suprapubic graft procedure. A further 2 (9.5%) cases of lymphatic leakage were detected in the group of patients who underwent subclavian artery transposition. After the surgical treatment of a femoral artery pseudoaneurysm, lymphorrhea occurred in 15 (18.07%) patients. Only in the group of patients who underwent percutaneous procedures, i.e. when treating thoracic and abdominal aorta aneurysms without dissecting femoral arteries, were no lymphatic complications observed.

Postoperative wound suppuration in the groin occurred in 11 (0.7%) cases whereas in 2 instances (0.1%) septic bleeding was reported due to complete decay of the femoral artery in patients after profundoplasty with a Dacron patch sewn in, and femoropopliteal bypass graft surgery. Prolonged wound healing, after the lymphatic leakage had stopped and the infection had been cured, led to femoropopliteal bypass graft clotting in 2 (0.1%) patients.

## Results

For the purposes of statistical evaluation, the post-hoc ANOVA test of Statistica v. 10 was used. Statistically significant results were those for which $p < 0.05$. They are highlighted in red in Table II. What can be clearly observed when analyzing the scores in the first column is that the frequency of occurrence of lymphatic leakage is statistically significant in comparison to TAVI with the emergency EVAR procedure, and then with femoropopliteal bypass graft surgery, femoral embolectomy, profundoplasty, and pseudoaneurysm. The second column contains a comparison of results between patients who underwent planned endovascular surgery due to an abdominal aorta aneurysm and other surgical procedures. As above, these scores are statistically significant for similar groups of patients, except the patients after femoral embolectomy, where no statistical significance was determined ($p = 0.084$). The third column presents a comparison of results in relation to an emergency EVAR procedure. In such a perspective, statistical significance only emerged for the comparison with the TAVI procedure and fascial closure. In the remaining pairs, this significance was not detected. Comparing the TEVAR procedure with other procedures, statistical significance only occurred in relation to the femoral artery pseudoaneurysm surgical procedure, where $p = 0.008$. A comparison between the emergency TEVAR procedure and all other types of procedures included in the study and presented in column 5 indicated statistical significance only when compared to fascial closure ($p = 0.035$). The sixth column contains scores for patients operated on due to AAD relative to other groups. Statistical significance was demonstrated only for a pair-wise comparison with pseudoaneurysm surgery. Column 7 shows a comparison between planned classical AAA treatment results with the remaining types of surgery. In this case, sta-

**Table II.** Post-hoc analysis, ANOVA

| | {1} | {2} | {3} | {4} | {5} | {6} | {7} | {8} | {9} | {10} | {11} | {12} | {13} | {14} | {15} | {16} |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 0.018 | 0.048 | 0.119 | 0.058 | 0.136 | 0.051 | 0.044 | 0.153 | 0.061 | 0.110 | 0.090 | 0.108 | 0.111 | 0.095 | 0.180 | 0 |
| {1} | | 0.287 | 0.032 | 0.359 | 0.051 | 0.498 | 0.454 | 0.075 | 0.162 | 0.006 | 0.024 | 0.010 | 0.063 | 0.214 | 1.8E-Q5 | 0.660 |
| {2} | 0.287 | | 0.095 | 0.792 | 0.122 | 0.951 | 0.885 | 0.150 | 0.569 | 0.017 | 0.084 | 0.033 | 0.167 | 0.422 | 2.8E-Q5 | 0.183 |
| {3} | 0.032 | 0.095 | | 0.264 | 0.799 | 0.239 | 0.112 | 0.671 | 0.186 | 0.848 | 0.521 | 0.815 | 0.892 | 0.730 | 0.208 | 0.023 |
| {4} | 0.359 | 0.792 | 0.264 | | 0.240 | 0.891 | 0.745 | 0.237 | 0.950 | 0.226 | 0.446 | 0.260 | 0.353 | 0.587 | 0.008 | 0.236 |
| {5} | 0.051 | 0.122 | 0.799 | 0.240 | | 0.217 | 0.128 | 0.846 | 0.195 | 0.661 | 0.433 | 0.640 | 0.718 | 0.602 | 0.474 | 0.035 |
| {6} | 0.498 | 0.951 | 0.239 | 0.891 | 0.217 | | 0.890 | 0.216 | 0.823 | 0.209 | 0.396 | 0.238 | 0.317 | 0.530 | 0.010 | 0.338 |
| {7} | 0.454 | 0.885 | 0.112 | 0.745 | 0.128 | 0.890 | | 0.150 | 0.581 | 0.047 | 0.148 | 0.067 | 0.180 | 0.411 | 0.0003 | 0.286 |
| {8} | 0.075 | 0.150 | 0.671 | 0.237 | 0.846 | 0.216 | 0.150 | | 0.211 | 0.562 | 0.394 | 0.546 | 0.610 | 0.521 | 0.727 | 0.052 |
| {9} | 0.162 | 0.569 | 0.186 | 0.950 | 0.195 | 0.823 | 0.581 | 0.211 | | 0.0852 | 0.279 | 0.123 | 0.286 | 0.566 | 0.0004 | 0.110 |
| {10} | 0.006 | 0.017 | 0.848 | 0.226 | 0.661 | 0.209 | 0.047 | 0.562 | 0.085 | | 0.505 | 0.947 | 0.986 | 0.804 | 0.050 | 0.006 |
| {11} | 0.024 | 0.084 | 0.521 | 0.446 | 0.433 | 0.396 | 0.148 | 0.394 | 0.279 | 0.505 | | 0.576 | 0.662 | 0.935 | 0.009 | 0.022 |
| {12} | 0.010 | 0.033 | 0.815 | 0.260 | 0.640 | 0.238 | 0.067 | 0.546 | 0.123 | 0.947 | 0.576 | | 0.951 | 0.834 | 0.053 | 0.010 |
| {13} | 0.063 | 0.167 | 0.892 | 0.353 | 0.718 | 0.317 | 0.180 | 0.610 | 0.286 | 0.986 | 0.662 | 0.951 | | 0.823 | 0.178 | 0.043 |
| {14} | 0.214 | 0.422 | 0.730 | 0.587 | 0.602 | 0.530 | 0.411 | 0.521 | 0.566 | 0.804 | 0.935 | 0.834 | 0.823 | | 0.176 | 0.148 |
| {15} | 1.8E-Q5 | 2.8E-Q5 | 0.208 | 0.008 | 0.474 | 0.010 | 0.0003 | 0.727 | 0.0004 | 0.050 | 0.009 | 0.053 | 0.178 | 0.176 | | 4.7E-Q5 |
| {16} | 0.660 | 0.183 | 0.023 | 0.236 | 0.035 | 0.338 | 0.286 | 0.052 | 0.110 | 0.006 | 0.022 | 0.010 | 0.043 | 0.148 | 4.7E-Q5 | |

tistical significance was discovered for the comparison with patients operated on due to femoral artery pseudoaneurysm, and in patients who underwent femoropopliteal bypass graft surgery. The eighth column shows the results of a pair-wise comparison between the patients operated on due to rAAA and the remaining groups. In this configuration, none of the compared pairs of procedures showed statistical significance. It needs to be noted that the score closest to statistical significance was the comparison with fascial closure ($p = 0.052$). The ninth column presents the scores of comparisons for the aortobifemoral bypass graft surgery. Statistical significance occurred only in comparison with the group of patients operated on due to femoral artery pseudoaneurysm. The tenth column contains the results of a comparison relative to lymphatic leakage after the femoropopliteal bypass graft surgery. Statistical significance also occurred when comparing the aforementioned surgery with TAVI, EVAR, planned AAA surgery, and fascial closure. The eleventh column shows the results of a comparison between femoral artery embolectomy and the remaining operations. Statistical significance was established when femoral artery embolectomy was compared with TAVI, the femoral artery pseudoaneurysm procedure, and fascia closure. The twelfth column presents a comparison of results for profundoplasty. Values of $p < 0.05$ were found for the comparison with TAVI, EVAR, as well as the pseudoaneurysm procedure and fascial closure. The thirteenth column comprises scores for the suprapubic vascular graft procedure. Statistical significance was determined for the pair-wise comparison with the group of patients in whom fascial closure was performed. The fourteenth column presents the comparison of results for the subclavian artery transposition surgery. As we can see, no statistical significance was determined here. In the fifteenth column, a comparison between the pseudoaneurysm procedure and other types of surgery indicated statistical significance for TAVI, planned EVAR, planned TEVAR, AAD, planned classical AAA, aortobifemoral bypass graft surgery, and fascial closure. The sixteenth and last column shows the results of a comparison with fascial closure. Here, statistical significance was observed when comparing fascial closure with emergency EVAR, emergency TEVAR, femoropopliteal bypass graft surgery, femoral artery embolectomy, profundoplasty, the suprapubic vascular graft procedure, and femoral artery pseudoaneurysm.

The number of procedures comprising the groups under comparison has an influence on the final results. Hence, for sets with the lowest number, the scores are unreliable. Nevertheless, the analysis of 1,580 procedures allows certain regularities to be discerned. It has been established beyond doubt that mini-invasive and planned procedures bring about the fewest lymphatic complications. In addition, particular attention should be paid to closing the femoral artery by using the fascial closure technique where this complication was not observed. In addition, procedures necessitating the dissection of the femoral artery, particularly those performed multiple times, increase the risk of lymphatic leakage. For instance, profundoplasty or the suprapubic vascular graft procedure is performed as a last resort, when no other options for lower-extremity revascularization are available. Most frequently, they supplement previous interventions.

During the observation period, the leakage of lymphatic fluid stopped spontaneously in the majority of patients. The remaining patients were treated conservatively, with postoperative wounds being healed completely within 7–16 days from the moment the leakage occurred. All patients were administered multitarget antibiotics (third-generation cephalosporin and metronidazole), whereas in selected cases a targeted antibiotic therapy was applied. At that time, in severe cases of lymphorrhea, i.e. in patients where > 500 ml/day of lymph fluid was drained, nutrition administered orally was stopped. Instead, the patients were fed parenterally for 5–7 days. In some cases, good results were achieved by attempting compression therapy used after mini-invasive procedures, which involved putting a dressing on the femoral puncture site and wrapping it with an elastic bandage. This type of compression was successfully applied in 11 patients. It was maintained for 72 h, with dressings changed 1–2 times every day and a new elastic bandage applied. In the treatment of the most unresponsive patients, wound revision was performed along with the multilayer suture of the wound and the puncturing of sites that could constitute potential sources of lymphorrhea. The wound was revised in 8 (0.5%) patients. In 4 (0.25%) patients with partial wound dehiscence and lymphatic leakage, a vacuum-assisted closure therapy was applied. In all these cases, the wound was healed within 120 h after the surgery when the lymph fluid had stopped leaking. Further treatment was typical and involved granulation tissue formation.

In the aforementioned 2 patients in whom septic bleeding occurred, common femoral artery ligation was performed. Forty-eight and 72 h respectively after the surgical intervention, the patients had to undergo thigh-level amputation surgery. In both cases, wounds in the groin healed by granulation, and the stumps healed *per primam*.

## Discussion

The lymphatics of the lower extremity consist of superficial and deep layers including vessels and nodes. The clusters of lymph nodes are variably distributed throughout the body and linked to one another by lymphatic vessels. These clusters form so-called vertical and horizontal bands. The number of superficial nodes is considerably higher than the deep nodes [1, 9]. Scarpa's triangle is the most common surgical access site to the femoral artery. Due to the close anatomic location of the vessel-abundant lymphatic and blood circulatory systems, it is impossible to bypass reactively enlarged lymph nodes and connections between them. Reactive enlargement of lymph nodes in this area is quite often observed due to prolonged lower extremity arteriosclerosis, and in effect limb ischemia, but also due to abrasions, injuries, as well as toe and foot inflammation. This occurs particularly frequently in patients with a diabetic foot [10]. The latter can be symptomatic of the currently ongoing or past inflammatory condition. Inflammation may originate in the inflammatory processes of the perineum, genitals, anus, rectum, and reproductive organs. It also happens that cancerous and tuberculous changes in lymphatic nodes are diagnosed. *(*Hence, within the authors' department, in all cases where enlarged lymphatic nodes are diagnosed in this area, a sample is taken for pathomorphological examination. Based on the sample material taken thus far, 1 patient was diagnosed with tuberculosis and another with lymphoma.)* Despite a very thorough examination of patients prior to planned surgery, it is very often impossible to establish based on the patient interview an unequivocal cause for the lymphatic nodes to be enlarged in this area. Further risk factors conducive to the development of lymphatic fistula are: advanced age of patients, diabetes, wound infection, reoperation, the use of a synthetic prosthesis resulting in an inflammatory response and tissue irritation (e.g. PTFE or Dacron), excessive wound electrocoagulation, incorrect suture technique that leaves empty spaces, and excessive patient mobility after an operation [1, 2, 7, 10, 11].

To prevent potential lymphorrhea from occurring, the lymphatic nodes should be bypassed by dissecting tissues lateral to them. In the event of lymph node dissection, it is necessary to puncture and ligate them *(*optional resection of lymph nodes entails the possibility of lymphedema of the surrounding tissues or the entire extremity on the operated side, associated with a temporary disturbance of lymph drainage)*. From a technical point of view, in order to avoid lymph node dissection, a longer curved skin incision can be made externally to the lymph nodes, with the formation of a skin flap that is moved medially. This can give access to the subcutaneous layer and the femoral fascia. This approach is particularly recommended in patients with inflammatory and necrotic changes of the distal lower extremity [12]. Unfortunately, this approach does not entirely eliminate the incidence of lymphorrhea due to the transection of connecting small lymph vessels, which, if solely electrocoagulated or imprecisely ligated, have a tendency to reopen. Lymphorrhea prevention can also involve multilayer suture and thorough closure of the surgical wound. In the past, attempts were made to use fibrin glue to treat these patients [1, 13].

The incidence of lymphorrhea after vascular surgery undoubtedly impedes wound healing, increasing the cost of treatment, whereas prolonged lymphorrhea can lead to infection and wound suppuration. Mild lymphorrhea is cured following conservative treatment. However, more intense lymphorrhea triggering an inflammatory response in the surgical wound, as well as causing internal lymph pockets and partial wound dehiscence, necessitates surgical reintervention, or local vacuum-assisted therapy application [14–17]. Persistent lymphatic leakage, i.e. above 100 ml/day, is an indication for surgical intervention. In extreme cases, when the lymphatic leak reached 500 ml/day, parenteral nutrition was stopped and intravenous supplementation was administered instead. In selected cases, a dose of 3.5 μg/kg b.w./h of somatostatin IV was administered by means of an infusion pump [5, 6, 18]. The somatostatin infusion was maintained for 72 h on average. Moreover, conservative treatment involved: lying with slightly lifted lower extremities, compression dressings, the puncture of the lymph pocket and the evacuation of the lymph fluid, local wound treatment, and, depending on the local wound condition, intravenous administration of antibiotics.

The healing of a wound itself, after persistent lymphorrhea accompanied by the inflammatory response in the wound, does not eradicate the problem. The problem lies in the deep and hard scar tissue that can “draw in” vessels, i.e. an artery or a bypass graft, in the area where anastomosis was previously performed. As a consequence, this can lead to narrowing of the vessel or the anastomotic site, and subsequently to clotting. Hard scars make it difficult to reoperate in this area. It is not so rare that lymphorrhea can also complicate the technical success of reoperation [19].

The lymphatic system has, however, an amazing regenerative and continuity restoring capacity after transection or ligation. Therefore, the proportion of lymphatic fistulas occurring for this reason is relatively low, which indicates that the choice of incision is not entirely responsible for it.

As we can see, the problem of lymphatic fistula occurrence is quite complex. They are not limited to vascular interventions but can occur after any type of surgery. They can be observed after other procedures, particularly oncological procedures, for example as a consequence of extensive lymphadenectomy [4]. It should be stressed that video-assisted surgery as a minimally invasive technique protects sufficiently against lymphorrhea [20, 21].

Maintaining due thoroughness when dissecting tissues and treating the cutting line in this area with ligatures and tissue puncture are the most reliable methods of minimizing the risk of lymphatic leakage after surgical procedures performed in a classical way. The lymphatic complication under analysis is far less likely to occur when procedures are performed as planned and an endovascular technique is used.

## Conclusions

Minimally invasive and fully percutaneous procedures performed via needle puncture, including the use of the fascial closure technique to close the femoral artery, eliminate the likelihood of the occurrence of this vascular complication.

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