# Inguinal lymph node dissection: Epidermal vacuum therapy for prevention of wound complications

**Robert Tauber [a], Sebastian Schmid [a], Thomas Horn [a], Mark Thalgott [a], Matthias Heck [a], Bernhard Haller [b], Hubert Kübler [a], Michael Autenrieth [a], Margitta Retz [a], Jürgen E. Gschwend [a], Tobias Maurer [a,*]**

[a] *Department of Urology, Technische Universität München, Klinikum rechts der Isar, Ismaninger Str. 22, 81671 Munich, Germany*
[b] *Institute for Medical Statistics and Epidemiology, Technische Universität München, Klinikum rechts der Isar, Munich, Germany*

**KEYWORDS**
Inguinal lymph node dissection;
Penile cancer;
Prevention;
Vacuum therapy;
Wound complication

* Corresponding author. Tel.: +49 089 4140 2522; fax: +49 089 4140 4818.
*E-mail address:* t.maurer@lrz.tum.de (T. Maurer).

Penile cancer represents a rare disease with an incidence rate of 0.5—1.6 per 100,000 males in Europe and the United States.[1] In the treatment of patients with penile cancer inguinal lymph node dissection (LND) is indicated for pathological stages pT1 G3 or higher or when palpable lymph nodes are present. However, surgery in the inguinal region is often associated with significant morbidity for the patients. Breakdown of inguinal wounds with protracted secondary healing, prolonged lymph leakage or formation of lymphoceles can occur in up to 30—70% of patients.[2—7] These complications can further lead to secondary infections with skin-flap necrosis, leg and scrotal oedema, compression of blood vessels with thrombosis and pain.[6,8—11] Aetiology for inguinal wound breakdown is fostered by anatomical stress on connective tissue, poor nutritional status in adipose tissue and persistent lymphorrhoea or seroma formation. Risk factors for lymphorrhoea and seroma formation are multifactorial and triggered by impaired drainage of lymphatic fluid or lymphorrhoea from severed lymphatic vessels, local inflammatory processes, surgically created dead space and the use of electrocautery providing an ideal basis for infection.[3,12] Additional risk factors include previous surgery to the groin, the presence of foreign material or co-morbidities such as hypertension, nicotine abuse or diabetes.[8]

Different treatment modalities for persistent lymphorrhoea have been proposed. Basic recommendations include bed rest, prophylactic antibiotic treatment and pressure dressings. Therapeutic options include non-operative measures such as needle aspiration or external drainage, instillation of different sclerosing agents such as povidone iodine,[13] bleomycin,[14] doxycycline,[6] alcohol,[9,15] polidocanol,[8] fibrin sealant,[16,17] subcutaneous injection of the somatostatin-analogue octreotide[18] or radiotherapy.[10,19] Surgical reinterventions include subtile wound revision, debridement and selective ligation of leaking lymphatics — in some cases with the assistance of intra-operative lymphatic mapping[20—22] or microsurgical lymphaticovenous anastomosis.[23] In addition, the use of muscle flaps (e.g., sartorius muscle flap) has been described.[24] Furthermore, the use of subatmospheric or negative pressure therapy in inguinal wound failures with persistent lymphorrhoea has been suggested.[17,25—28] Despite this multitude of treatment options so far there has been no consensus on the most effective treatment.

However, even more desirable is the prevention of inguinal complications to decrease morbidity and enhance the patients' quality of life. Furthermore, potentially necessary oncological treatments can be administered without delay, thus improving oncological outcomes. Careful dissection, preservation of the saphenous vein when possible, and subtile preparation and ligation of lymphatic vessels form the basis to prevent inguinal complications.[29] In addition, transposition of a sartorius muscle flap or even pedicled omentoplasty has been proposed.[24,30] Furthermore, prophylactic use of fibrin glue,[31,32] collagen powder[33] or subcutaneous application of octreotide has been evaluated in preventing lymphorrhoea after axillary LND.[12] Recently, subatmospheric pressure or vacuum therapy has been examined on closed surgical wounds as postoperative dressing to provide a clean, dry wound environment and to decrease the development of postoperative seromas in the wound and improve wound healing.[34—36]

Therefore, the goal of our retrospective study was to evaluate epidermal vacuum therapy for the prevention of wound complications following inguinal LND.

## Materials and methods

### Patients

From January 2009 to March 2012, a total of 24 patients with penile cancer or cancer of the urethra received uni- or bilateral inguinal LND in our institution (Table 1). In these patients, a total of 45 inguinal LNDs were performed in a modified (according to the medial and central zones I, IV and V of the inguinal LND template defined by Daseler et al.[37]) or radical fashion (medial, central and lateral zones I—V) depending on the pT-stage of primary tumour or the presence of metastatic spread to LN on frozen sections. Clinical charts were reviewed and patients were contacted in order to determine the rate of wound complications.

### Postoperative wound care

After inguinal LND all patients received a closed suction vacuum drain through a separate incision (High-VAC 400 ml Ward-System, Dahlhausen, Köln, Germany). Drains remained in place for at least 4 days and were removed upon cessation of drained fluid. Drained fluid was measured daily, and post-surgical complications were recorded. In the group treated with conventional wound care (CWC) compression dressings were placed on the wound for 24 h following subcutaneous and intracutaneous wound closure (16 patients). In the group treated with epidermal vacuum dressings (VAC) a polyvinyl alcohol dressing (V.A.C.® White Foam Dressing, KCI Medizinprodukte GmbH, Wiesbaden, Germany) was applied on the closed wound, sealed with adhesive drape and connected to a vacuum therapy unit (ActiVAC, KCI Medizinprodukte GmbH, Wiesbaden, Germany) following subcutaneous suturing and wound closure with a stapler device (eight patients) (Figure 1). Pressure settings were −100 mmHg, continuous, intensity +++. In the case of bilateral inguinal LND, one vacuum therapy unit was connected to both epidermal vacuum dressings. Epidermal vacuum dressings were kept for up to

**Table 1** Patients' characteristics.

| | CWC | VAC | *p* |
|---|---|---|---|
| No of pts. | 16 | 8 | |
| No of inguinal LND | 30 | 15 | |
| Age (years) | 59.8 ± 10.4 | 60.5 ± 11.9 | 0.891[a] |
| BMI (kg $m^{-2}$) | 26.5 ± 4.4 | 28.9 ± 8.0 | 0.486[a] |
| Pathological stage and grade (per pt.)[b] | | | |
| pT1 | 3 | 2 | |
| pT2 | 7 | 6 | |
| pT3 | 4 | 0 | |
| pT4 | 2 | 0 | 0.312[c] |
| G1 | 2 | 0 | |
| G2 | 5 | 6 | |
| G3 | 9 | 2 | 0.173[c] |
| pT1-4 N+ | 7/16 (43.8%) | 2/8 (25.0%) | 0.657[c] |
| Radical LND | 16/30 (53.3%) | 6/15 (40.0%) | 1.00[c,d] |
| LN (total)[e] | 7.8 ± 3.8 | 9.1 ± 6.1 | 0.599[a] |
| LN (metastatic)[e] | 0.8 ± 1.5 | 0.3 ± 0.8 | 0.248[a] |
| Inguinal LND with metastatic LN | 9/30 (30.0%) | 2/15 (13.3%) | 0.657[c,d] |

CWC: conventional wound care; VAC: epidermal vacuum dressing; pt(s).: patient(s); BMI: body mass index; No: number; LN: lymph node; LND: lymph node dissection(s).

[a] *t*-test.

[b] Included in the CWC group are five pts. with carcinoma of the urethra: pT1 N+, pT3 N+, pT3 N0, pT4 N+ and pT4 N0, all G3.

[c] Fisher's test.

[d] On a patient basis.

[e] Per inguinal LND.

7 days and subsequently removed. Patients decided on an individual basis on the mode of postoperative wound care. Written informed consent was obtained from all patients included in the VAC group. Patients were discharged from hospital after they were completely mobilised and sufficient wound healing had been achieved.

## Statistical analysis

Statistical analysis was performed with SPSS version 19.0 (Statistical Package for Social Science, SPSS Inc., Chicago, IL, USA). Clinical data were reported using descriptive statistics. Mean and standard deviation are shown for normally distributed data, median and interquartile range for skewed quantitative data. Absolute and relative frequencies are presented for qualitative data. Two-sample *t*-tests were performed to compare treatment groups for symmetrically distributed quantitative data (age, body mass index (BMI)); otherwise, Mann—Whitney *U*-tests were applied (duration of drainage and maximal drained fluid). Binary data were compared with Fisher's exact test. A two-sided level of significance of $\alpha = 0.05$ was used for all tests. Due to the fact that each inguinal LND does not represent an independent observation, statistical calculations of postoperative complications were performed on a patient level only.

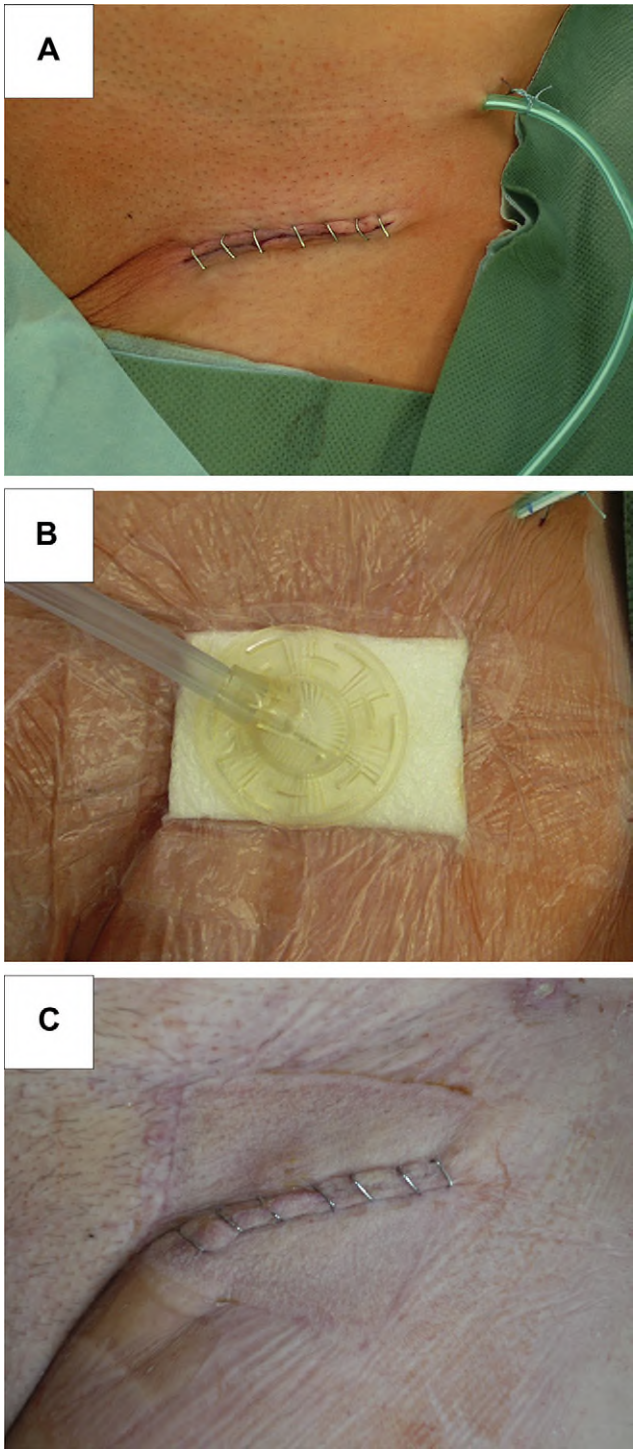


**Figure 1** Application of epidermal vacuum dressing (VAC): after wound closure using a stapler device (A) a polyvinyl alcohol dressing is applied on the closed wound, sealed with adhesive drape and connected to a vacuum therapy unit (B). Typical wound status after removal of the epidermal VAC on postoperative day seven (C).

## Results

Sixteen patients (30 inguinal LNDs) were treated with CWC and eight patients (15 inguinal LNDs) were treated with

epidermal vacuum dressing (VAC) postoperatively. There were no significant differences between the two treatment groups concerning age, BMI, histopathological stage, lymph node (LN)-positive patients, extent of LND (radical vs. modified), resected LN (per inguinal LND) or occurrence of metastatic disease to inguinal LND templates (Table 1).

Postoperatively maximum drained fluid per day from inguinal wounds showed a tendency for higher values in CWC treated patients (25%-percentile: 30 ml; median: 68 ml; 75%-percentile: 200 ml) than in patients with epidermal VAC (25%-percentile: 35 ml; median: 55 ml; 75%-percentile: 78 ml; Figure 2A). In addition, by trend, prolonged lymphorrhoea resulted in delayed removal of surgical drains of CWC treated patients (25%-percentile: 6 days; median: 7 days; 75%-percentile: 18 days) in contrast to epidermal VAC treated patients (25%-percentile: 5 days; median: 7 days; 75%-percentile: 8 days; Figure 2B). While drainages had to be kept in place for more than 7 days in only 1/15 (8%) inguinal LND wounds treated with epidermal VAC, 15/30 inguinal CWC treated wounds (50%) required a drainage time longer than 7 days. In comparison to only 1/8(13%) patients of the VAC treated group 4/16 (25%) patients of the CWC group were discharged from our clinic with indwelling drainages ($p = 0.631$). However, statistical significance on a patient level could be demonstrated neither for duration of drainage ($p = 0.632$) nor for maximum drained fluid per day ($p = 0.496$) due to our small patient cohorts. On the other hand, patients with epidermal VAC treated wounds could be discharged from our hospital earlier (25%-percentile: nine days; median: nine days; 75%-percentile: 11 days) than patients with CWC treatment (25%-percentile: 10 days; median: 14 days; 75%-percentile: 19 days; Figure 2C). Despite the low number of included patients this difference proved statistically significant ($p = 0.049$).

Rates of postoperative complications were associated with the mode of wound care (Figure 3). Compared to CWC treated inguinal wounds, epidermal VAC treated groins showed fewer formation of lymphoceles (62% vs. 20%), less persistent lymphorrhoea (45% vs. 7%) or lymphoedema of the lower extremity (46% vs. 0%). No deep venous thrombosis occurred in either group. In general, significantly fewer patients with epidermal VAC treated inguinal wounds experienced inguinal wound complication compared to patients with CWC treatment ($p = 0.032$). Reinterventions had to be performed for 7/30 (23%) inguinal wounds treated with CWC and in 1/15 (7%) groins treated with epidermal VAC. Reinterventions in the CWC group included percutaneous radiotherapy in five cases, repeated insertion of drainages in two cases, surgical resection of fibrous lymphocele wall and instillation of fibrin glue in one case as well as reoperation and placement of a subcutaneous vacuum dressing with regular changes every 3–5 days for up to 35, 49 and 80 days until cessation of lymphorrhoea in three cases. The reintervention for the patient (BMI 43.8 kg $m^{-2}$) with persistent lymphorrhoea of the VAC treated group consisted of reoperation and placement of a subcutaneous vacuum dressing with regular changes every 3–5 days for up to 80 days until cessation of lymphorrhoea and complete secondary healing.

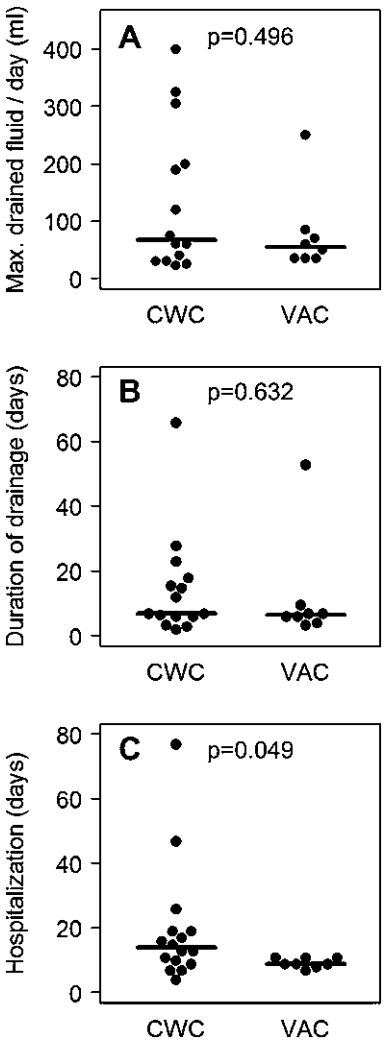


**Figure 2** Comparison of maximal drained fluid per day (A), duration of wound drainage (B) and duration of hospitalisation (C) between CWC and epidermal VAC treated patients (median and values for each patient are shown; in case of bilateral LND mean value for maximal drained fluid and duration of wound drainage for both sides was used; CWC: conventional wound care; VAC: vacuum dressing).

## Discussion

Inguinal LND is associated with significant morbidity. Thus, prevention of postoperative complications is of major importance — not only in terms of improving patients' quality of life or cutting down on costs for the health-care system, but also in terms of avoiding delay of necessary additional oncological therapies eventually resulting in improved prognosis of these patients.

The basis for prevention represents careful surgical dissection and meticulous preparation. Above these recommendations, there is only sparse evidence on effective preventive measures for groin complications after inguinal LND. Erba et al. evaluated the influence of a sartorius muscle transposition on postoperative lymphorrhoea in 28 patients with melanoma and inguinal LND. In this study, transposition of a sartorius muscle flap

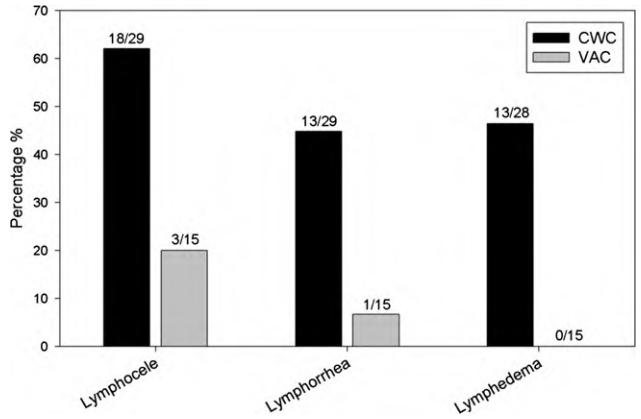


**Figure 3** Comparison of postoperative complications between CWC and epidermal VAC treated inguinal LND wounds (Percentages as well as absolute numbers are shown; CWC: conventional wound care; VAC: vacuum dressing).

was not associated with reduced drainage time nor reduced groin wound complications.[24] Similarly, pedicled omentoplasty has been proposed to prevent inguinal complications after ilioinguinal lymph node dissection. In a pilot study one wound breakdown in seven patients was observed.[30] However, this surgical technique represents a rather radical approach necessitating a second abdominal incision and might furthermore promote spread of tumour cells to the peritoneal cavity — even if in this study at 4 months follow-up no patient experienced peritoneal carcinomatosis. Postoperative application of collagen or fibrin sealant after axillary LND has also been described to moderately attenuate lymphorrhoea and reduce drainage time in two randomised studies with 80 and 40 breast cancer patients.[31,33] On the contrary, fibrin glue could not demonstrate a significant benefit in a prospectively randomised trial with 43 patients undergoing extended oesophagectomy, but rather seemed to induce postoperative lymph flow.[32] In a large prospective trial, 261 consecutive breast cancer patients were randomised to receive either no treatment or subcutaneous injections of the somatostatin-analogue octreotide after axillary LND. Amount as well as duration of lymphorrhoea were significantly reduced in the octreotide-treated group. Thus, the authors concluded that subcutaneous application of octreotide might be able to successfully prevent post-axillary LND lymphosarcoma.[12]

In our retrospective study, we examined the use of epidermal vacuum dressings (VAC) to prevent complications after inguinal LND. Since the mid-1990s negative or subatmospheric pressure therapy has been introduced into the management of complex wounds.[36,38–40] Subatmospheric pressure therapy results in the stimulation of fibroblast migration and proliferation, angiogenesis and tissue growth while at the same time reducing wound oedema and removing wound exudate, thus supporting wound healing.[35,38,41] While vacuum therapy is traditionally used for complex wound healing disorders, it only was recently introduced as preventive therapy in the form of epidermal vacuum dressings after primary wound closure to reduce wound complication rates. In a first case series of four patients with high-risk wounds for the development of postoperative wound complications epidermal vacuum therapy was safely and successfully applied on clean closed surgical wounds.[42] In a study by Atkins et al., 57 patients were treated with an epidermal VAC after sternotomy. In this high-risk patient cohort, three postoperative wound infections were anticipated but may have been mitigated by the epidermal vacuum therapy.[35] Another randomised trial with 19 patients evaluated the use of epidermal vacuum therapy vs. conventional wound dressings to improve wound healing after total hip arthroplasty. In this study, epidermal VAC significantly reduced postoperative wound seromas and improved primary wound healing.[34]

Thus, these studies concluded that among patients with significant co-morbidities or increased risk for wound complications epidermal vacuum therapy might prove beneficial. Accordingly, in our study we observed a decrease of maximal drained fluid per day and duration of indwelling drainage in patients treated with epidermal VAC after inguinal LND. However, this difference did not reach statistical significance on a patient basis. Compared to conventionally treated patients in the VAC treated group less formation of postoperative lymphocele, lymphorrhoea or lymphoedema of the lower extremities was observed. Patients treated with epidermal VAC after inguinal LND were significantly less likely to experience wound complications. In addition, median time of postoperative hospitalisation was significantly decreased from 14 days to 9 days for patients with epidermal VAC therapy. Although more patients in the CWC treated group showed metastatic disease to inguinal LN and this condition might influence wound healing negatively, we could not observe an increase of postoperative wound complications in LN-positive patients. However, our study is limited in its power of comparison due to its retrospective approach, the small number of cases available, the lack of a standardised reporting system for complications and does not include the influence of the surgeon nor surgical sub-specialities. Furthermore, only urological patients were included in this retrospective study not evaluating results of epidermal VAC therapy after inguinal LND for gynaecological malignancies or melanoma or even open inguinal vascular procedures. Despite these obvious limitations, the results might still reflect an advantage of epidermal VAC therapy for prevention of complications in the postoperative care of patients undergoing inguinal LND. Besides improving patient's comfort or quality of life, epidermal VAC could furthermore even reduce time of hospitalisation and hence costs for the health-care system. In addition, further oncological treatments could be administered without delay. These results and currently available information suggest that prospective and randomised clinical studies of epidermal vacuum therapy in the prevention of postoperative wound complications to assess the efficacy as well as cost-effectiveness are warranted.

## Conclusions

Epidermal VAC following inguinal LND might be advantageous for the prevention of postoperative wound

complications and thus reduce time of hospitalisation. Prospective and randomised clinical studies of epidermal vacuum therapy in the prevention of postoperative wound complications to assess the efficacy as well as cost-effectiveness are warranted.

## Funding

None.

## Author contribution

All authors have made substantial contributions to all of the following:

- conception and design of the study, acquisition of data or analysis and interpretation of data
- drafting the article or revising it critically for important intellectual content
- final approval of the submitted version

## Conflict of interest

None. The authors have no commercial associations that might pose or create a conflict of interest with information presented in this article.

We also confirm that the current "Guide for Authors" has been read, the conditions mentioned have been accepted and instructions have been followed including the policy on ethical consent.

## References


1. Pizzocaro G, Algaba F, Horenblas S, et al. EAU penile cancer guidelines 2009. *Eur Urol* 2010;**57**:1002—12.
2. Ornellas AA, Kinchin EW, Nobrega BL, et al. Surgical treatment of invasive squamous cell carcinoma of the penis: Brazilian National Cancer Institute long-term experience. *J Surg Oncol* 2008;**97**:487—95.
3. Bevan-Thomas R, Slaton JW, Pettaway CA. Contemporary morbidity from lymphadenectomy for penile squamous cell carcinoma: the M.D. Anderson Cancer Center experience. *J Urol* 2002;**167**:1638—42.
4. Perdona S, Autorino R, De Sio M, et al. Dynamic sentinel node biopsy in clinically node-negative penile cancer versus radical inguinal lymphadenectomy: a comparative study. *Urology* 2005;**66**:1282—6.
5. Han LY, Schimp V, Oh JC, et al. A gelatin matrix-thrombin tissue sealant (FloSeal) application in the management of groin breakdown after inguinal lymphadenectomy for vulvar cancer. *Int J Gynecol Cancer* 2004;**14**:621—4.
6. Caliendo MV, Lee DE, Queiroz R, et al. Sclerotherapy with use of doxycycline after percutaneous drainage of postoperative lymphoceles. *J Vasc Interv Radiol* 2001;**12**:73—7.
7. Kretschmer L, Thoms KM, Peeters S, et al. Postoperative morbidity of lymph node excision for cutaneous melanoma-sentinel lymphonodectomy versus complete regional lymph node dissection. *Melanoma Res* 2008;**18**:16—21.
8. Klode J, Klotgen K, Korber A, et al. Polidocanol foam sclerotherapy is a new and effective treatment for post-operative lymphorrhea and lymphocele. *J Eur Acad Dermatol Venereol* 2010;**24**:904—9.
9. Sawhney R, D'Agostino HB, Zinck S, et al. Treatment of postoperative lymphoceles with percutaneous drainage and alcohol sclerotherapy. *J Vasc Interv Radiol* 1996;**7**:241—5.
10. Dietl B, Pfister K, Aufschlager C, et al. Radiotherapy of inguinal lymphorrhea after vascular surgery. A retrospective analysis. *Strahlenther Onkol* 2005;**181**:396—400.
11. Shermak MA, Yee K, Wong L, et al. Surgical management of groin lymphatic complications after arterial bypass surgery. *Plast Reconstr Surg* 2005;**115**:1954—62.
12. Carcoforo P, Soliani G, Maestroni U, et al. Octreotide in the treatment of lymphorrhea after axillary node dissection: a prospective randomized controlled trial. *J Am Coll Surg* 2003; **196**:365—9.
13. Gilliland JD, Spies JB, Brown SB, et al. Lymphoceles: percutaneous treatment with povidone-iodine sclerosis. *Radiology* 1989;**171**:227—9.
14. Kerlan Jr RK, LaBerge JM, Gordon RL, et al. Bleomycin sclerosis of pelvic lymphoceles. *J Vasc Interv Radiol* 1997;**8**:885—7.
15. Zuckerman DA, Yeager TD. Percutaneous ethanol sclerotherapy of postoperative lymphoceles. *AJR Am J Roentgenol* 1997;**169**:433—7.
16. Silas AM, Forauer AR, Perrich KD, et al. Sclerosis of postoperative lymphoceles: avoidance of prolonged catheter drainage with use of a fibrin sealant. *J Vasc Interv Radiol* 2006;**17**:1791—5.
17. Greer SE, Adelman M, Kasabian A, et al. The use of subatmospheric pressure dressing therapy to close lymphocutaneous fistulas of the groin. *Br J Plast Surg* 2000;**53**:484—7.
18. Kim WT, Ham WS, Koo KC, et al. Efficacy of octreotide for management of lymphorrhea after pelvic lymph node dissection in radical prostatectomy. *Urology* 2010;**76**:398—401.
19. Mayer R, Sminia P, McBride WH, et al. Lymphatic fistulas: obliteration by low-dose radiotherapy. *Strahlenther Onkol* 2005;**181**:660—4.
20. Schwartz MA, Schanzer H, Skladany M, et al. A comparison of conservative therapy and early selective ligation in the treatment of lymphatic complications following vascular procedures. *Am J Surg* 1995;**170**:206—8.
21. Steele SR, Martin MJ, Mullenix PS, et al. Intraoperative use of isosulfan blue in the treatment of persistent lymphatic leaks. *Am J Surg* 2003;**186**:9—12.
22. Stadelmann WK, Tobin GR. Successful treatment of 19 consecutive groin lymphoceles with the assistance of intraoperative lymphatic mapping. *Plast Reconstr Surg* 2002;**109**:1274—80.
23. Morihisa Y, Inoue Y, Kiyokawa K, et al. Objective assessment of the efficacy of supermicrosurgical lymphaticovenous anastomosis and microsurgical lymphaticovenous implantation in a case of axillary lymphorrhea. *J Reconstr Microsurg* 2008;**24**: 29—32.
24. Erba P, Wettstein R, Rieger UM, et al. A study of the effect of sartorius transposition on lymph flow after ilioinguinal node dissection. *Ann Plast Surg* 2008;**61**:310—3.
25. Hamed O, Muck PE, Smith JM, et al. Use of vacuum-assisted closure (VAC) therapy in treating lymphatic complications after vascular procedures: new approach for lymphoceles. *J Vasc Surg* 2008;**48**:1520—4.
26. Denzinger S, Lubke L, Roessler W, et al. Vacuum-assisted closure versus conventional wound care in the treatment of wound failures following inguinal lymphadenectomy for penile cancer: a retrospective study. *Eur Urol* 2007;**51**:1320—5.
27. Abai B, Zickler RW, Pappas PJ, et al. Lymphorrhea responds to negative pressure wound therapy. *J Vasc Surg* 2007;**45**:610—3.
28. Steenvoorde P, Slotema E, Adhin S, et al. Deep infection after ilioinguinal node dissection: vacuum-assisted closure therapy? *Int J Low Extrem Wounds* 2004;**3**:223—6.
29. Zhang SH, Sood AK, Sorosky JI, et al. Preservation of the saphenous vein during inguinal lymphadenectomy decreases

morbidity in patients with carcinoma of the vulva. *Cancer* 2000;**89**:1520—5.
30. Benoit L, Boichot C, Cheynel N, et al. Preventing lymphedema and morbidity with an omentum flap after ilioinguinal lymph node dissection. *Ann Surg Oncol* 2005;**12**:793—9.
31. Mustonen PK, Harma MA, Eskelinen MJ. The effect of fibrin sealant combined with fibrinolysis inhibitor on reducing the amount of lymphatic leakage after axillary evacuation in breast cancer. A prospective randomized clinical trial. *Scand J Surg* 2004;**93**:209—12.
32. Tachibana M, Kinugasa S, Yoshimura H, et al. Does fibrin glue reduce lymph leakage (pleural effusion) after extended esophagectomy? Prospective randomized clinical trial. *World J Surg* 2003;**27**:776—81.
33. Stafyla V, Dimakakos E, Koureas A, et al. Effect of collagen powder on lymphorrhea after modified radical mastectomy. A randomized controlled trial. *Eur J Gynaecol Oncol* 2011;**32**:185—7.
34. Pachowsky M, Gusinde J, Klein A, et al. Negative pressure wound therapy to prevent seromas and treat surgical incisions after total hip arthroplasty. *Int Orthop* 2012;**4**:719—22.
35. Atkins BZ, Wooten MK, Kistler J, et al. Does negative pressure wound therapy have a role in preventing poststernotomy wound complications? *Surg Innov* 2009;**16**:140—6.
36. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. *Ann Plast Surg* 1997;**38**:563—76 [discussion 577].
37. Daseler EH, Anson BJ, Reimann AF. Radical excision of the inguinal and iliac lymph glands; a study based upon 450 anatomical dissections and upon supportive clinical observations. *Surg Gynecol Obstet* 1948;**87**:679—94.
38. Argenta LC, Morykwas MJ, Marks MW, et al. Vacuum-assisted closure: state of clinic art. *Plast Reconstr Surg* 2006;**117**: 127S—42S.
39. Morykwas MJ, Argenta LC, Shelton-Brown EI, et al. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. *Ann Plast Surg* 1997;**38**:553—62.
40. Morykwas MJ, Simpson J, Punger K, et al. Vacuum-assisted closure: state of basic research and physiologic foundation. *Plast Reconstr Surg* 2006;**117**:121S—6S.
41. Saxena V, Hwang CW, Huang S, et al. Vacuum-assistedclosure: microdeformations of wounds and cell proliferation. *Plast Reconstr Surg* 2004;**114**:1086—96 [discussion 1088—97].
42. Stannard JP, Atkins BZ, O'Malley D, et al. Use of negative pressure therapy on closed surgical incisions: a case series. *Ostomy Wound Manage* 2009;**55**:58—66.