Leg Ulcer Recurrence and its Risk Factors: A Duplex Ultrasound Study before and after Vein Surgery

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Objectives. Assessment of risk factors for ulcer recurrence in chronic leg ulcer patients treated by varicose vein surgery.

Design. Retrospective follow-up study.

Materials. 62 patients, 43 women and 19 men (Median = 56.5 years, range 24–77) with the CEAP classifications of C5–C6 and E3 (primary venous insufficiency).

Methods. Patients underwent colour duplex ultrasound (CDU) investigation before varicose vein surgery. Post-operatively CDU, ambulatory venous pressure (AVP) and an interview were performed. The median clinical follow-up was 5.5 years (range 2–11 years).

Results. The estimated 5-year ulcer recurrence rate was 19% in all patients. The risk of ulcer recurrence was significantly lower (p < 0.05) in legs without residual varices or recurrence. The five year risk of ulcer recurrence depended on the time interval between ulcer appearance and the surgical intervention (index operation), post-operative venous axial reflux and AVP (mmHg). More than 50% of the patients had a calculated probability of ulcer recurrence of less than 3%, but 13% had a probability of more than 23% based on our analysis.

Conclusions. A long history of venous ulcer is a pre- and post-operative risk factor for recurrent ulceration. Total elimination of incompetent superficial and perforator veins lowers the risk of ulcer recurrence, whereas residual axial reflux increases the risk. Postoperative CDU is effective in identifying patients at risk of ulcer recurrence.

Keywords: Colour duplex ultrasound; Superficial venous surgery; Venous ulcer recurrence; Risk factors.

Introduction

Chronic venous insufficiency is the principal cause of about 70% of all leg ulcers.1–3 Chronic leg ulcer reduces the quality of life and restricts individual social function.4,5 Conservative treatment of leg ulcers may lead to complete healing but recurrence is common, although occurs less frequently in patients who comply with advice to wear compression stockings.6 Surgical treatment of varicose veins is an alternative to strict conservative management, which is associated with frequent varicose vein recurrence.7,8

Venous imaging by colour duplex ultrasound (CDU) has substantially improved the evaluation of chronic venous insufficiency9–13 and has become the method of choice for testing individual veins of superficial, deep and perforating systems.14 In patients with venous leg ulcers, we and others found that 50% of patients had superficial venous incompetence alone, 35% had combined superficial and deep venous incompetence, and the remaining 15% of ulcer patients had vein deep incompetence alone.13,15–17 Patients with superficial venous incompetence, especially when this is the only venous reflux in the limb are suitable for varicose vein surgery. This may lead to more rapid ulcer healing and improved venous function compared to compression treatment alone. Surgery should be directed towards correcting venous reflux found in any site on CDU.18–20

This retrospective follow-up study of surgically treated chronic leg ulcers patients was conducted to assess the long-term outcome of the surgical intervention for venous disease. Our aim was to identify risk factors for ulcer recurrence based on CDU examination and ambulatory venous pressure (AVP) measurement.

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Methods

Patients

This study was considered and approved by the local ethics committee in accordance to the Helsinki conference of human rights. 62 consecutive patients gave their consent to inclusion in this study. They had 62 chronic leg ulcers attributable to primary venous incompetence. Between 1990 and 1997, the patients were referred from a number of outpatient clinics and by general practitioners to the Department of Clinical Physiology for pre-operative CDU investigations. All patients were investigated post-operatively by further CDU examination after a median of 32 months (range 3–96 months). The patients were post-operatively interviewed by one of us (MM) on two occasions. The first occasion was during the years 1997–2001 at the post-operative CDU re-examination and the second time was by telephone during the years of 2002–2003 (median interval: 5.5 years, range 2–11 years). The interview included questions about ulcer duration, use of compression stockings and family history of venous ulcers. All patients had chronic primary venous insufficiency (Ep) of grade C5 (healed ulcer n = 50) or C6 (active ulcer n = 12) according to the CEAP classification. Secondary venous incompetence and obstruction was excluded by history, CDU and VOP (venous outflow plethysmography). None had clinically significant peripheral arterial disease as indicated by an ankle-brachial index greater than 0.8. Prior to the surgery for superficial venous incompetence (index operation), on which this study was focused, other venous surgery had been performed in 38 legs (38/62, 61%), of whom 14 had undergone GSV interventions. Eighteen patients underwent partial stripping or ligation of GSV segments in the thigh or calf, or anterior accessory saphenous veins. Sixteen patients underwent ligation at the sapheno-popliteal junction followed by stripping or partial stripping of the small saphenous vein (SSV). Thirty-two patients underwent open subfascial ligation of (one to four) perforating veins whereas 13 additional patients were treated with subfascial endoscopic perforator surgery (SEPS).

Ulcer history

Preoperatively, leg ulcers were located medially in fifty-two limbs, laterally in six limbs and four had both medial and lateral ulcers. In the six limbs with lateral ulcers, four had SSV incompetence. Prior to the index operation, the median total ulcer duration (i.e. the cumulative duration of all active ulcers, from the first ulcer to index operation) was 13.5 months (range 1.5–120 months). We used the time interval from the first ulcer to the index operation as a measure of the duration of ulcer disease. The median ulcer duration for the whole group was 60 months with a range of 4–336 months. The median number of ulcer episodes was 2 (range 1–20). The first ulcer occurred in women at median age of 48 years (range 23–63 years) and in men at 41 years, (range 15–74 years).

Venous surgery

A median of four months (range 0.5–43 months) after the preoperative CDU examination, superficial venous surgery was performed by senior residents and included ligation of the sapheno-femoral junction, stripping of the great saphenous vein (GSV) from the groin to the mid-calf region combined with ligation of tributaries or stab avulsions (phlebectomies), (n = 38). Eighteen patients underwent partial stripping or ligation of GSV segments in the thigh or calf, or anterior accessory saphenous veins. Sixteen patients underwent ligation at the sapheno-popliteal junction followed by stripping or partial stripping of the small saphenous vein (SSV). Thirty-two patients underwent open subfascial ligation of (one to four) perforating veins whereas 13 additional patients were treated with subfascial endoscopic perforator surgery (SEPS).

Colour doppler ultrasound

The post-operative CDU examination was performed a median of 32 months (range 3–96 months) after the surgical intervention (index operation), between 1997–2001, using a 5 MHz linear probe (Acuson 128XP/10, Acuson Corp., Mountain View, Calif.). Venous valve function was assessed by experienced examiners according to a standardized protocol and validated techniques. Venous reflux in any vein

<table>
<thead>
<tr>
<th>Table 1. Clinical data (mean, SD) at the re-examination</th>
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</thead>
<tbody>
<tr>
<td>Women/men</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>Weight (kg)</td>
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<tr>
<td>Height (cm)</td>
</tr>
<tr>
<td>BMI</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
</tr>
<tr>
<td>Family history of ulcer</td>
</tr>
<tr>
<td>Stockingsa</td>
</tr>
<tr>
<td>Previous surgery</td>
</tr>
<tr>
<td>Previous surgery other leg</td>
</tr>
<tr>
<td>Working/retired</td>
</tr>
<tr>
<td>BMI = body mass index, SBP = systolic blood pressure, DBP = diastolic blood pressure.</td>
</tr>
<tr>
<td>a With compression class I.</td>
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</tbody>
</table>
was semi-quantitatively graded from the colour scale with respect to its duration and its maximum frequency shift (0 = none, 1 = mild, 2 = moderate and 3 = severe reflux). Veins in thigh and in popliteal fossa were examined in a 40° head-up tilt position during repeated Valsalva manoeuvres and pneumatic calf cuff inflations/deflations. Calf veins and perforators were tested with the patient sitting on a bed with the foot in the examiner’s lap using manual calf or foot compression for testing reflux. Incompetent perforating veins were considered to be clinically significant if the diameter was >3 mm. Venous reflux was classified as superficial (Sr = great and/or small saphenous vein and included perforator incompetence), deep (Dr = femoral and/or deep femoral, popliteal and/or deep calf veins including the gastrocnemius vein) or combinations of both (SrDr). A reflux grade ≥2 was considered to be pathological. As shown before in the methodological study15 all significant reflux of grades 2–3, as used in this study, were of durations longer than 1 s.

We related ulcer recurrence to the outcome of the post-operative CDU examination by sub-grouping patients in categories of residual or recurrent venous reflux (referred to as residual reflux in this text). Superficial residual reflux includes great saphenous (GSV) and/or small saphenous vein (SSV) incompetence as well as accessory incompetent veins and/or tributaries above or below the knee. Deep reflux includes incompetent deep veins in any leg compartment.

Reflux scoring

CDU results before and after surgery were quantified by a venous segmental disease score (VSDS) as proposed by Rutherford et al.22 but also by its modification (i.e. functional venous disease score, FVDS), which includes scoring of proximal and distal segmental venous reflux grades (Table 2). Axial venous reflux, i.e. venous valve incompetence of grade 2–3 uninterrupted all the way from the common femoral vein to the ankle veins, was considered for comparison with FVDS and VSDS in a model of predicting ulcer recurrence. Axial reflux to ankle veins was observed within superficial or deep veins, or within serial combinations of superficial and deep reflux pathways.

Venous outflow plethysmography (VOP)

Conventional venous outflow strain gauge plethysmography (Phlebotest, Eureka Biotech AB) was used in order to exclude venous obstruction by measuring the maximum venous outflow rate (ml/100 ml/min).

Ambulatory venous pressure (AVP)

Venous pressure measurements were obtained from a superficial vein on the dorsum of the foot connected to a transducer23 (PC Polygraph HR, Synectics Medical). Continuous pressure recordings and evaluations (Polygram, Medtronic) were performed with the patient standing upright and holding onto a frame. After resting pressure assessment, the patient performed a standard exercise of 10 tiptoe movements at the rate of one per second. After the exercise, the patient remained resting until the vein pressure returned to the pre-exercise level. The 10 tiptoe movements were repeated 3 times. The time for the pressure to return to the standing pressure level after the 10 tiptoe movements was the venous refilling time (VRT) and the 90% recovery time was calculated (VRT90). The AVP was defined as the lowest pressure obtained in any of three tiptoe manoeuvres. A VRT90 < 20 seconds or an AVP >30 mm Hg was considered abnormal.22

Predicting ulcer recurrence

A pre- and post-operative model is presented in an attempt to predict ulcer recurrence.
1. Before surgery we tested to see if any variable would predict a high risk of ulcer recurrence which would guide the surgeon in his decision whether or not to operate.

2. After the index operation (surgical intervention), we attempted to identify risk factors indicating the likelihood of ulcer recurrence which could suggest the need for extra care and clinical follow-up. This also included an attempt to compare different anatomical and haemodynamic scoring-systems.

Statistics

Data was analysed on a PC using Microsoft Access, Excel, and SPSS for Windows Advanced Statistical Package (version 11.0). Results are presented as median values with corresponding ranges or mean values ± standard deviation. The Mann Whitney (2-tailed) test was used for comparison of between groups differences and the Wilcoxon signed ranks (2-tailed) test for comparison of within groups differences. The probability of 5 year ulcer recurrence was estimated by means of the general relationship between survival and hazard functions. For each variable a Poisson regression (Breslow and Day) was performed in order to assess the importance of the variable for the risk of recurrence. In a stepwise procedure the variables with a significant relationship to recurrence, when considered one by one, were included. The Poisson regression applied here meant that the hazard function of recurrence was estimated as a function of the form exp($b_0 + b_1 \cdot x_1 + \cdots + b_n \cdot x_n$). A hazard function gives the number of events per person year at different time periods of follow up. By use of the hazard function the probability of recurrence could be calculated.

Results

Ulcer history

Multiple ulcers and long ulcer duration were common in all patients before the surgical procedure. The duration of ulcer disease at the index operation was significantly longer in the patients with recurrent ulcers in comparison to those patients with healed ulcers (182.4 versus 46.6 months, $p < 0.001$). All $C_6$ legs ($n = 9$) healed after surgery at a median of 4 weeks (range 2–40 weeks). Two of the initial $C_6$ legs and 13 of $C_5$ legs suffered ulcer recurrence. The telephone interview 2–11 years (median 5.5 years), after the index operation revealed that 47 out of the 62 legs (76%) remained free from ulcers during this period. The 5-year ulcer recurrence rate in all patients was 19%. The 15 legs with ulcer recurrence had one to two ulcer episodes during post-operative follow-up (median 6 years), and the median total duration of recurrent ulcers was 10 months (range 2–18 months). Time to ulcer recurrence varied from one to six years after the index operation.

No leg ulcer recurrence occurred in patients free from post-operative venous incompetence, as well as in those with segmental reflux, but in combination with significant shorter duration of ulcer disease (mean 62.8 S.D. 70.0 months in 33 ulcer free patients versus 234.8 S.D 78.3 months in patients with ulcer recurrence).

Colour doppler imaging

Pre-operatively 42 patients were found to have superficial venous insufficiency without deep reflux (SrDo) and 20 patients with both superficial and deep vein incompetence (SrDr). Post-operatively, no detectable venous reflux (SoDo) was seen by CDU in 15 legs, of which three patients had mixed venous incompetence pre-operatively. None of these patients had post-operative ulcer recurrence. Forty-three patients had remaining superficial reflux post-operatively, either combined with deep reflux (SrDr, $n = 20$), or not (SrDo, $n = 23$). In another four patients only deep reflux was present at CDU follow-up (SoDr). Fifteen of the 47 (35%) patients with any type of reflux were experienced ulcer recurrence post-operatively (6/23, 26% in superficial; 7/20, 35% in mixed and 2/4, 50% in deep insufficiency group). Table 3 compares the individual incompetent vein compartments before and after the surgical intervention.

Venous disease score

Table 4 shows that VSDS, FVDS as well as the sites of axial reflux, decreased significantly ($p < 0.001$), at post-operative follow-up in the patients without ulcer recurrence, but not in those patients with recurrent ulcers.

Ambulatory venous pressure measurements (AVP)

AVP was only available at post-operative follow-up. Patients with residual reflux ($n = 47$) had significantly higher AVP values when compared with those patients ($n = 15$) free from residual reflux (mean 32.1 S.D. 10.5 mmHg versus 20.0 S.D. 11.2, $p < 0.001$).
VRT90 was significantly shorter in patients with residual reflux (mean 10.8 S.D. 5.9 s versus 20.9 S.D. 9.4 s, p < 0.001). No differences in AVP and VRT90 were observed when comparing SrDo with SrDr. In patients without ulcer recurrence or in those without residual reflux AVP normalised post-operatively. VRT also normalised in legs without residual reflux.

Risk factors for recurrence of post-operative leg ulcers

Pre-operative risk factors: Duration of ulcer disease at the index operation is a significant predictor of post-operative ulcer recurrence in a multivariate model (Table 5a). This analysis identifies a small group at high risk, i.e. 20% of the patients have a calculated 5 year probability of recurrence of more than 25%, but more than 40% have a probability less than 4% (Fig. 1). The β-coefficient (0.0124), indicated an increase in risk of 1% per month from first ulcer. The risk continues even after the index operation (time since operation). Table 5b presents variables considered for the multivariate analysis pre-op calculated one by one. Insignificant variables were patients age, gender, isolated residual reflux of superficial (SrDo), deep (SoDr) or mixed (SrDr) reflux.

Post-operative risk factors: The variables indicating high risk of recurrent ulcers were the duration of ulcer disease at the index operation, axial reflux and a high post-operative AVP (Table 6a). The multivariate analysis shows that 50% of the patients have a calculated 5 year probability of ulcer recurrence of less than 3%, but 13% have a probability of more than 23% (Fig. 2). The 5 year calculated probability of recurrence of leg ulcer did not change when excluding AVP, i.e. assessment of the time ulcer disease at index operation and post-operative CDU-findings of axial reflux, are strong indicators on ulcer recurrence. The β-coefficient (0.503), indicated on a risk increase of 65% per increase with one axial reflux grade unit. The risk continues significantly even after index occasion (time since operation). Table 6b presents variables considered for the multivariate analysis post-operatively calculated one by one.

Discussion

The outcome of venous surgery is variable, especially when the operation is performed to prevent for recurrence of leg ulcers.6,24–27 The aim this retrospective post-operative follow-up study was to assess the

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
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<tr>
<td>Constant</td>
<td>−5.1856</td>
<td>0.7705</td>
<td>0.0000</td>
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<tr>
<td>Time ulcer disease at index operation (years)</td>
<td>0.1488</td>
<td>0.0324</td>
<td>0.0000</td>
</tr>
<tr>
<td>Current time since index operation (years)</td>
<td>0.1723</td>
<td>0.1156</td>
<td>0.1361</td>
</tr>
</tbody>
</table>

There was no variable contributing significantly to the prediction of ulcer recurrence except the duration of ulcer disease at index operation (time from first ulcer to index operation).

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effects of superficial and perforator vein surgery on venous haemodynamics, ulcer healing and at identifying possible risk factors for ulcer recurrence.

We found that 24% of the patients suffered recurrent ulcers during the period of 2–11 years after surgery (after the index operation). Every active ulcer healed after surgery, but the estimated 5-year ulcer recurrence rate was only 19% overall. In patients with recurrent leg ulcers, the post-operative CDU showed either recurrent or residual incompetent reflux, such as uncorrected GSV and SSV junctions, other residual reflux or perforators. However, in many patients there

Fig. 1. The ability to predict ulcer recurrence within 5 years. By means of the beta coefficient for the variable duration of ulcer disease at index operation a risk score can be calculated for each patient. The score is equal to the sum of the products of the coefficient and the value of the corresponding variable. The higher the score is, the greater the risk of recurrence. x-value = 0.5 corresponds to median. More than 40% of the patients have a calculated 5 year probability of recurrence less than 4% and 20% have a probability of more than 25%.

Table 5b. Results obtained by Poisson regression when considering the variables one by one

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>0.0286</td>
<td>0.0131</td>
<td>0.0290</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>0.0229</td>
<td>0.0102</td>
<td>0.0248</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>0.0535</td>
<td>0.0239</td>
<td>0.0252</td>
</tr>
<tr>
<td>Ulcer episodes</td>
<td>0.0937</td>
<td>0.0412</td>
<td>0.0230</td>
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<tr>
<td>Ulcer duration (months)</td>
<td>0.0167</td>
<td>0.0068</td>
<td>0.0141</td>
</tr>
<tr>
<td>Surgery episodes</td>
<td>0.3580</td>
<td>0.1692</td>
<td>0.0344</td>
</tr>
<tr>
<td>Time ulcer disease</td>
<td>0.1344</td>
<td>0.0300</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>at index operation (years)</td>
<td>0.1139</td>
<td>0.0300</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AVP (mmHg)</td>
<td>0.0751</td>
<td>0.0319</td>
<td>0.0186</td>
</tr>
<tr>
<td>Duration of ulcer disease</td>
<td>0.1488</td>
<td>0.0396</td>
<td>0.0033</td>
</tr>
</tbody>
</table>

The variables, which were measured after the index operation (except the duration of ulcer disease at index operation), contributed significantly to the prediction of ulcer recurrence.

![Figure 1](image1.png)

Fig. 2. The ability to predict ulcer recurrence within 5 years. By means of the beta coefficient for the variable duration of ulcer disease at index operation, axial reflux and AVP a risk score can be calculated for each patient. The score is equal to the sum of the products of the coefficient and the value of the corresponding variable. The higher the score is, the greater the risk of recurrence. Abbreviations: AVP = ambulatory venous pressure. x-value = 0.5 corresponds to median. More than 50% of the patients have a calculated 5 year probability of recurrence of less than 3% and 13% have a probability of more than 23%.

Table 6a. Result of the stepwise procedure in a post-op multivariate model, aimed to identify patients at high risk for ulcer recurrence among the operated patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>−8.5738</td>
<td>1.5661</td>
<td></td>
</tr>
<tr>
<td>Current time since</td>
<td>0.2901</td>
<td>0.1205</td>
<td>0.0161</td>
</tr>
<tr>
<td>index operation (years)</td>
<td>0.5030</td>
<td>0.1940</td>
<td>0.0095</td>
</tr>
<tr>
<td>axial reflux</td>
<td>0.0751</td>
<td>0.0319</td>
<td>0.0186</td>
</tr>
<tr>
<td>Duration of ulcer disease</td>
<td>0.1488</td>
<td>0.0396</td>
<td>0.0033</td>
</tr>
</tbody>
</table>

The post-operative CDU showed either recurrent or residual incompetent reflux, such as uncorrected GSV and SSV junctions, other residual reflux or perforators. However, in many patients there

![Figure 2](image2.png)

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was a delay between the surgical intervention and postoperative CDU. This might make distinguishing surgical errors from recurrent venous insufficiency more difficult, even though the findings of unchanged GSV and SSV suggest incomplete surgery. When those patients with suspected incomplete surgery are excluded, only 8 out of 55 legs (14%) developed recurrent ulcers during the median of 5.5 years follow-up. The risk of developing new ulcers is low when the surgeon removes all superficial and perforator reflux, i.e. no recurrent ulcers were observed in legs without post-operative venous reflux. In contrast, residual venous incompetence was associated with recurrence in 32% of cases. The frequency of repetitive interventions is also important, since no ulcer recurrence was seen in legs operated upon for the first time (n = 14).

According to Ghauri et al., ulcer recurrence within 1 year was reduced to 9% with specialised vascular community service and superficial venous surgery as compared to a 50% recurrence rate without surgical correction of superficial reflux. Barwell et al. found a lower ulcer recurrence rate 3 years after varicose vein surgery (26%) when compared to non-operated patients (44%) with only superficial reflux. According to data from one existing randomised trial, the one year recurrence rate was significantly lower after superficial venous surgery (12%) as compared to compression treatment alone (28%). They also showed a significant benefit of surgery in patients with additional segmental deep venous incompetence, but not in the subgroup with axial deep venous incompetence.

Danielsson et al. have reported that residual venous incompetence with axial reflux is of great importance in causing recurrent ulcers, a finding that we have confirmed. A long history of venous ulcer is also an important factor. We found the duration of ulcer disease at the index operation to be the most important pre-operative risk variable for post-interventional ulcer recurrence (Fig. 1). Predicting ulcer recurrence after the index operation from the duration of ulcer disease, axial reflux and AVP showed that more than 50% of the patients have a calculated 5 year probability of recurrence less than 3% (Fig. 2). However, assessment of the duration of ulcer disease and axial reflux are stronger indicators of ulcer recurrence, since the five year probability of ulcer recurrence did not change when excluding AVP (Fig. 2, dotted line). The lack of a consistent relationship between individual ulcer recurrence and AVP might be dependent on various reflux kinetics; i.e. even though the muscle pump is effective in lowering AVP to normal values, a short VRT90 could rapidly re-establish venous hypertension lasting over long periods throughout the day. The multivariate model points to post-operative axial reflux as an important risk factor for recurrent leg ulcer, without additional influence of other variables, such as VSDS, FVDS or VRT90. However, this result may have been influenced by the somewhat small sample size.

When calculating the risk of ulcer recurrence according to the VRT90, VSDS and FVDS variables independently in all patients, high VSDS, FVDS and low VRT90 respectively, are significantly correlated with increased risk for ulcer recurrence. We modified VSDS (Rutherford et al.) to define the grade of axial reflux (score 2 or 3) but this modification (FVDS) did not improve the risk assessments.

Our patients with recurrent leg ulcers were older and heavier and three of them had knee joint disease. Therefore, limited mobility or poor ranges of leg joint motion might be an additional contributing factors for ulcer recurrence, which we were unable to evaluate within the present study (Back et al.). Gohel et al. found long ulcer healing times among elderly patients, and patients not treated with superficial venous surgery had an increased risk of leg ulcer recurrence.

We found substantial recurrent or residual deep and superficial venous insufficiency after surgery, which implies risk of ulcer recurrence. Because of low inter-observer variability at our department recurrent venous insufficiency might be explained by post-operative dilatation of accessory veins over time, by development of new incompetence in the early post-surgery phase or neovascularisation at a later stage. However, incomplete surgery might be a more important reason for residual reflux, and “missed” tributaries in the groin are very likely to be seen when inadequate

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**Risk Variables in Leg Ulcer Patients**

Table 6b. Results obtained by Poisson regressions when considering the variables one by one

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time ulcer disease at index operation (years)</td>
<td>0.1488</td>
<td>0.0324</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AVP (mmHg)</td>
<td>0.0906</td>
<td>0.0285</td>
<td>0.0015</td>
</tr>
<tr>
<td>VRT (s)</td>
<td>−0.2357</td>
<td>0.0738</td>
<td>0.0014</td>
</tr>
<tr>
<td>FVDS</td>
<td>0.3886</td>
<td>0.1263</td>
<td>0.0021</td>
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<tr>
<td>VSDS</td>
<td>0.3647</td>
<td>0.1427</td>
<td>0.0060</td>
</tr>
<tr>
<td>Axial reflux</td>
<td>0.7502</td>
<td>0.1823</td>
<td>&lt;0.001</td>
</tr>
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</table>

Significant variables considered for multivariate analysis post-op. The duration of ulcer disease at index operation was a pre-op variable, whereas the others were post-op variables. AVP = ambulatory blood pressure, VRT = venous refilling time, FVDS = functional venous disease score, VSDS = venous segmental disease score.
dissection of the sapheno-femoral junction has been performed.\textsuperscript{5,37,38} In the patient group with ulcer recurrence, at least five suspected cases of untreated great saphenous vein incompetence were found.

The time between the date of the index operation and its follow-up is important due to natural disease progression with venous recurrence. Long-term observation (31–39 years) revealed 60\% recurrence at the sapheno-femoral junction.\textsuperscript{39} In our series, the postsurgical examination was performed after 32.6 S.D. 22.1 months, which did not differ between patients with or without recurrent varicose veins. Untreated varicose vein segments were also found postoperatively, hence seven patients with recurrent ulcers were waiting for additional surgical interventions.

The changes in deep venous valve function after superficial venous surgery are also of interest. Localised deep reflux might be secondary to increased blood volume re-entry from superficial incompetence resulting in increased shear stress and vessel wall inflammation.\textsuperscript{40} This kind of segmental deep reflux might disappear after surgical correction of the superficial compartment, which we and others have observed.\textsuperscript{41–43} After GSV and SSV surgery, pre-operative deep reflux disappeared at follow-up in five legs with FV and in another five legs with POPV, out of which one of each belonged to the patient group with recurrent ulcers. New post-operative segmental deep vein reflux (in 12 of our patients) might occur when the deep venous system is exposed to higher hydrostatic blood pressure gradients after superficial venous surgery but more commonly we found legs with deep insufficiency in combination with residuals or recurrence of superficial insufficiency.

In a previous study we have found several dilated and incompetent perforators in leg ulcer patients with primary venous insufficiency.\textsuperscript{53} New incompetent perforators were observed post-operatively in 49\% of the patients with residual reflux, which is in accordance with Rutherford \textit{et al.}.\textsuperscript{44} Perforators may contribute to axial reflux through various incompetent segments in series of deep and superficial veins. Stuart \textit{et al.}\textsuperscript{55} stated that, when isolated superficial reflux was abolished, the proportion of incompetent perforators decreased, whereas in legs with remaining venous reflux most of the perforators remained incompetent. Gohel \textit{et al.}\textsuperscript{46} demonstrated that about one third of all incompetent calf perforators may be abolished by superficial venous surgery, whereas only few perforators regained competence and new ones became incompetent over time despite compression therapy. We found frequently distal GSV or BK residual reflux, which could be of importance, since these types of vessel were common in the patients with recurrent ulcers. The proportion of perforators at re-examination was 60\% versus 35\% in none ulcer recurrence group. However, isolated superficial reflux postoperatively (perforators included) was not a significant risk variable.

After long periods of pain and discomfort, most patients experienced clinical improvements after the index operation. Limited varicose vein recurrence or residuals might therefore not be of importance among active patients. Many patients though, preferred to continue with low compression, at least at work.

We conclude that CDU should always be used in diagnosing and classifying venous insufficiency shortly before and after surgical interventions. CDU is needed for post-operative assessment of risks for leg ulcer recurrence in order to identify all axial or other severe reflux, which might be treatable surgically.

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