INTRODUCTION
A common surgical procedure for treatment of primary varicose veins is sapheno-femoral ligation and stripping of the great saphenous vein (GSV) with multiple phlebectomies. Other less invasive treatment modalities, which are considered as effective as surgery, include radiofrequency or laser ablation of the GSV. After GSV stripping or ablation, the prescription of compression stockings to reduce hemorrhage, hematoma, edema, and pain is standard practice. However, patients frequently report difficulty in applying the compression stockings and discomfort during warm summer weather.

The optimal duration of compression therapy following varicose vein surgery remains controversial. Several randomized controlled trials (RCTs) compared various durations of elastic stocking treatment, and recommended wearing elastic stockings for 1 week postoperatively. Other reviews and guidelines advised wearing elastic compression...
MATERIALS AND METHODS

Selection criteria

For inclusion in our analyses, studies were required to be published RCTs that evaluated the optimal duration of compression therapy after surgery for varicose veins. Studies were also required to report the inclusion and exclusion criteria used for patient selection, the surgical techniques for varicose veins including conventional surgery and endovenous ablation, the compression strategy, and the definition and evaluation of postoperative outcomes. Studies were excluded from our analyses if patients received sclerotherapy for varicose veins only, or if duplicating reporting of patient cohorts had occurred.

Search strategy and study selection

Studies were identified using computerized searches of the PubMed, EMBASE, CINAHL, SCOPUS, Cochrane central register of controlled trials, and ClinicalTrials.gov registry (http://clinicaltrials.gov/) databases. The terms “varicose vein,” “ligation or stripping or endovenous ablation or surgery,” “duration,” and “compression or bandage or stocking” were used. The related article facility in PubMed was used to broaden the search, and all retrieved abstracts, studies, and citations were reviewed. Hand-searching of the reference lists of relevant systematic reviews and trial registries was also performed. No language restrictions were applied. The final search was performed during November 2012.

Data extraction

One reviewer extracted data from selected trials, a second reviewer verified the accuracy of data, and a third reviewer resolved any disagreements. A standard data extraction method was used to record the properties of each trial into a database, including the study design, study population characteristics, inclusion and exclusion criteria, matching criteria, surgical techniques used, compression strategy, operative parameters, complications, and postoperative parameters.

Methodological quality appraisal

The risk of study bias was assessed using the following evidence-based criteria: method of allocation concealment, randomization technique, double-blinding, and description of withdrawals. Data on funding sources, as well as reports on a priori sample size calculations, interim or preliminary analyses, intention-to-treat designs, and reports of surgical sequelae were also extracted. Two reviewers independently assessed each study. Disagreements were resolved through a consensus with a third party.

Outcomes assessments

The primary outcome was the severity of pain in the 1–8-week postoperative period. Postoperative pain was assessed using a 10-point visual analog scale. Secondary outcomes were the duration of absenteeism from work, leg volume, and the incidence of postoperative complications including bleeding, infection, seroma, and numbness.

Statistical analysis

Data were analyzed using Review Manager, version 5.1 (Cochrane Collaboration, Oxford, UK). A meta-analysis was performed according to the PRISMA guidelines. Standard deviations were estimated from the provided confidence interval (CI) limits, standard error, or range values. Results were pooled using risk ratios (RR) to summarize dichotomous results and the mean difference (MD) to summarize continuous results. The precision of an effect size was reported as a 95% CI. Because of expected differences between trials, results were combined using the DerSimonian and Laird random-effects model. Data were pooled for studies that exhibited adequate clinical and methodological similarity only. Statistical heterogeneity was assessed using the $I^2$ test, with $I^2$ quantifying the proportion of the total outcome variability attributable to variability among the studies.

RESULTS

Characteristics of the trials

Fig. 1 displays a flowchart to illustrate the process we used to select trials. Our initial search yielded 819 citations, of which we deemed 330 ineligible through the screening of titles and abstracts. We thus retrieved the full texts of 489 reports. Most of these were excluded from our final review for the following reasons: 95 were review articles; 9 were guidelines; 2 were animal studies; 22 used different comparisons; 338 discussed different topics; and 19 were not randomized trials. Four eligible trials remained after the elimination process, and Table 1 displays their characteristics.

The four evaluated trials were published between 1991 and 2009, and their sample sizes ranged between 104–220 patients. One trial described the recruited patients as stage C2 or C3 of the clinical, etiology, anatomic, and

![Flowchart for trial selection](image-url)
pathophysiologic (CEAP) classification. All eligible trials performed conventional ligation and stripping of the GSV and multiple phlebectomies. Patients in the short-duration group underwent standard elastic bandage compression of the proximal part of the GSV for 3 days postoperatively in one trial and for 1 week postoperatively in two trials. In one trial, patients in the short-duration group used sequential avulsion of the GSV and multiple stab avulsions for 3 days postoperatively. In the long-duration groups in the selected trials, the patients wore the compression stockings for 2–6 weeks following the use of standard elastic bandages for a 3–7-day period. Across all four studies, patient ages in the two treatment groups were comparable (Table 1).

Table 2 shows a summary of the methodological quality of the included trials. Two studies reported acceptable methods of randomization, one trial described the method of allocation concealment, one study reported the blinding of outcome assessors, and one study used intention-to-treat analysis. The number of patient cases lost to follow-up was acceptable (<20%) in two studies. One trial suffered 26% withdrawals, whereas another did not report the number of withdrawals.

Pain score

Three studies assessed postoperative pain using a 10-point visual analog scale. The pooled mean difference in the degree of pain score 1 week postoperatively was 0.52 (95% CI: 0.01–1.03) This difference indicated that long-duration compression more effectively reduced severity of leg pain than short-duration compression. However, this finding was irrelevant because the interventions in the two groups were identical at the time this was assessed 1 week postoperatively. Differences in the groups’ postoperative pain scores, with a weighted mean difference of −0.03 (95% CI: −0.53 to 0.47) 4 weeks postoperatively, and −0.01 (95% CI: −0.31 to 0.33) 6 weeks postoperatively, were non-significant (Fig. 2). Values of I² were 8% and 58% at different time points postoperatively, indicating moderate heterogeneity across the studies for 6 weeks postoperatively.

One study evaluated pain severity using subjective scores, which indicated that the percentage of patients experiencing leg pain was 7.9% in the short-duration group and 6.7% in the 3-week compression group, and 13.1% in the 6-week compression groups. Pain severity after wearing an elastic support for 1, 3, or 6 weeks post surgery showed non-significant differences.

Complications

Two trials reported incidences of postoperative complications, including hematoma, hemorrhage, infection, and seroma. The short-duration and long-duration groups showed non-significant differences, with an RR of 0.84 (95% CI: 0.60–1.18; Fig. 3). The value of I² was 0%, indicating a lack of heterogeneity across the studies.

Leg volume

One included trial evaluated leg volume (in milliliters) using an optoelectronic limb volumeter preoperatively, and at 3

### Table 1. Characteristics of studies fulfilling inclusion criteria in the meta-analysis.

<table>
<thead>
<tr>
<th>Author [year]</th>
<th>Inclusion criteria</th>
<th>Surgery</th>
<th>No. of patients (leg)</th>
<th>Age (year, mean ± SD)</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biswas [2007]</td>
<td>Primary varicose vein surgery for SFJ/GSV reflux</td>
<td>Ligation and stripping of the GSV and multiple phlebectomies</td>
<td>S: 110</td>
<td>L: 110</td>
<td>S: 3 days elastic bandages + 1 week TED stockings L: 3 days elastic bandages + 3 weeks TED stockings (Kendall TED stockings, Tyoc Healthcare, Hants PO13 0AS)</td>
</tr>
<tr>
<td>Houtermans-Auckel [2009]</td>
<td>CEAP stage C2 or C3</td>
<td>Ligation and stripping of the GSV and multiple phlebectomies</td>
<td>S: 52</td>
<td>L: 52</td>
<td>S: 3 days elastic bandages L: 3 days elastic bandages + 4 weeks stockings (23–32 mmHg; 2 weeks day and night, 2 weeks day only)</td>
</tr>
<tr>
<td>Raraty [1999]</td>
<td>N/A</td>
<td>Saphenous ligation, sequential avulsion of the GSV and multiple stab avulsions</td>
<td>S: 53 (64)</td>
<td>L: 52 (67)</td>
<td>S: 1 week elastic bandages L: 16 h crepe bandages + 6 weeks TED stockings (1 week day and night, 5 weeks day only)</td>
</tr>
<tr>
<td>Rodrigus [1991]</td>
<td>N/A</td>
<td>Stripping of the GSV and multiple phlebectomies</td>
<td>S: (84)</td>
<td>L1: (84) L2: (89)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Values are presented as mean ± standard deviation, except: as indicated by 1 mean (range). CEAP, clinical, etiologic, anatomic, and pathophysiologic classification; GSV, great saphenous vein; L, long-duration; S, short-duration; TED, thromboembolus deterrent; N/A, not available.
days, 2 weeks, and 4 weeks postoperatively. The differences in changes in leg volume between the long-duration and short-duration groups were non-significant ($P = .18$) 4 weeks postoperatively.

**Absenteeism from work**

Three trials evaluated the mean durations of absenteeism from work as outcome measures. In one trial, at any evaluation time point (less than 2 weeks, 2–6 weeks, and 6–12 weeks), the groups showed non-significant differences. Another study showed that patients in the short-duration group were absent from work for a median of 18 (range, 5–54) days, and that those in the long-duration group were absent from work for a median of 20 (range, 1–51) days; therefore, the two groups showed non-significant differences. However, in one trial, the short-duration group had a shorter duration of absenteeism from work (11 d on average, SD 7.5) than the long-duration group (15 d, SD 8.4; $P = .02$).

**DISCUSSION**

Postoperative pain, hematoma, and edema are common complications following varicose vein surgery of the GSV. Thus, the prescription of compression stockings after varicose vein surgery is standard practice worldwide. Overall, our study results indicated that long duration compression did not result in greater reductions in pain, postoperative complications, or absenteeism from work, or changes in leg volume, compared to short-duration compression after varicose vein surgery.

Wearing elastic stockings for a short duration has several advantages. When suggested for longer-term use compliance is often poor because of difficulties in putting the stockings on, discomfort and itching, and excessive warmth of the leg.

In one of our included trials, 63% of patients had discarded their stockings prior to the end of the 6-week follow up. The mean duration of wear of standardized full-length TED stockings was 4 weeks.

Shouler and Runchman assessed 99 patients undergoing GSV surgery and evaluated the optimal duration of compression, comparing who had removed their compression stockings with those who had adhered to instructions to wear for 6 weeks postoperatively. The incidence of thrombophlebitis in the two groups was identical; however, the group with uninterrupted compression reported experiencing greater comfort than the other group.

The studies we reviewed investigated several types of compression stockings. Mariani et al. evaluated the effectiveness of wearing 23–32-mmHg stockings with compression bandages for 2 weeks postoperatively. Their results showed that patients treated with the stockings were less likely to suffer from edema than those using

![Figure 2](image_url)
standard bandaging; however, postoperative pain showed non-significant differences. In our meta-analysis, patients in three of the included trials used TED stockings for long-duration treatment. However, in a study by Rodrigus and Bleyn, patients in the long-duration group wore tubegauze after wearing elastic bandages for 1 week. Although the compression protocol in the long-duration groups differed across studies, we identified no advantages to wearing compression stockings for more than 1 week after varicose vein surgery. Despite the pooled mean difference in the degree of pain score 1 week postoperatively being significantly lower in the long-duration compression group than in the short-duration compression group, such a result did not affect our recommendation for short-duration compression because both groups were receiving identical treatment 1 week postoperatively.

Interest in the use of minimally invasive treatments for varicose veins, including radiofrequency and endovenous laser ablation, has increased in recent years. However, none of the four RCTs we reviewed in our meta-analysis investigated the outcomes of durations of compression after minimally invasive surgery. Several RCTs and meta-analyses indicated that significant reductions in tenderness, ecchymosis, and hematoma were associated with minimally invasive treatments compared to conventional surgical treatment methods; thus, we suggest that short-duration compression can also be applied after minimally invasive surgery for varicose veins. However, limited data demonstrate the requirement for further randomized clinical trials on the duration of postoperative compression following minimally invasive surgery compared with conventional surgery.

Our included studies showed significant heterogeneity because of variations in clinical factors and the non-uniform reporting of clinical parameters. First, the compression protocol and types of stockings differed across the studies. Individual patient characteristics could also have potentially affected the evaluation outcomes. For example, three of the included studies did not report the CEAP classification of patients. In addition, none of the included trials standardized the practices of multiple surgeons, and differences in the experience levels of surgeons might have contributed to data heterogeneity.

The strengths of our review include our comprehensive search strategy for eligible studies, the systemic and explicit application of eligibility criteria, the careful consideration of study quality, and a rigorous analytical approach. However, our review was limited by the methodological quality of the original studies (Table 2). First, only half of the included studies reported an adequate technique for randomized allocation. Second, three studies reported a lack of blinding of the personnel assessing the outcomes. Third, most of the studies analyzed their data according to a per-protocol principle, which might have biased the evaluation of the effects of compression duration. Finally, the studies did not assess compliance with wearing the elastic stockings in the long-duration group systematically.

In conclusion, the results from our meta-analysis show that long-duration compression following varicose vein surgery does not result in greater reductions in postoperative pain, complications, or absenteeism from return to work compared to short-duration compression. Based on these results, we recommend the prescription of short-duration compression after varicose vein surgery in routine practice. However, we based our findings on a small body of evidence in which the methodological quality was not high. For a more detailed evaluation, further well-structured trials with improved standardization of compression treatment, types of stockings, and target populations are necessary.

AUTHOR DISCLOSURE
The authors (Tsai-Wei Huang, Chia-Chin Lin, Chyi-Huey Bai, Chih-Hsiung Wu and Ka-Wai Tam) have no conflicts of interest or financial ties to disclose.

REFERENCES


