# Superficial femoral popliteal vein: An anatomic study

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*Objective:* The superficial femoral popliteal vein (SFPV) has been used as an alternative conduit for both arterial and venous reconstructive surgery. Its popularity continues to grow, despite concern about the potential for venous morbidity after harvest. The purpose of this study was to determine an anatomic "safe" length of SFPV for harvest, assuming that the preservation of at least one valve and one significant collateral vein in the remaining popliteal vein (PV) segment can minimize venous morbidity.

*Methods:* Forty-four SFPVs were harvested from 39 cadaveric specimens. The length of both the superficial femoral vein (SFV) and PV was measured, and the number and location of valves and significant side branches (more than 2 mm in diameter) of the PV were measured. The Student two-tailed *t* test was used as a means of comparing vein lengths between the sexes. Correlation coefficients were determined for the effect of patient height on vein length, stratified by means of sex.

*Results:* Vein length (SFV mean, 24.4 ± 4 cm; PV mean, 18.8 ± 4 cm) varied with sex (male SFV mean, 28.1 ± 5 cm; male PV mean, 21.5 ± 3 cm; female SFV mean, 22.6 ± 4 cm; female PV mean, 18.4 ± 3 cm; $P = .01$). Valve number (mean, 1.8 ± 0.5) and location and collateral vein number (mean, 5 ± 1.8) and location were variable and independent of height or sex.

*Conclusion:* An anatomic "safe" length of SFPV for harvest to minimize venous morbidity would include all the SFV and 12 cm of PV in 95% of women and 15 cm of PV in 95% of men. We found that the male sex was a significant determinant for a longer safe length of vein that can be harvested. (J Vasc Surg 2000;31:450-5.)

The superficial femoral popliteal vein (SFPV) has become well-established as an alternative conduit for infrainguinal, aortoiliac, and major venous reconstructions.[1-5] Fear that SFPV harvest will result in significant morbidity because of acute and chronic venous hypertension persists, and most investigators report some degree of leg swelling immediately after harvest.[6-9] However, some investigators report harvest of the conduit with minimal or no long-term morbidity, whereas other investigators note significant early and late morbidity.[6-9] Intuitively, the key to preventing morbidity appears to be the status of the veins remaining after the harvest of the SFPV, particularly the popliteal vein (PV). Therefore, the length of vein harvested, the presence of venous competence (of the remaining deep veins after femoral popliteal vein harvest), and the collateral vessels between the PV and profunda femoris vein (PFV) are thought to be important in preventing significant postharvest morbidity. With these factors in mind, we performed a cadaver study to determine: (1) the average lengths of both the superficial femoral vein (SFV) and the PV; (2) the number and location of valves in the PV; (3) the number and location of significant (more than 2 mm in diameter) collateral veins in the PV; and (4) the average "safe length" of SFPVs that can be harvested, preserving at least one valve and one significant collateral vein

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Fig 1. Cadaveric dissection of the popliteal vein demonstrating collateral veins (*arrows*). The groin is to the right, and the knee is to the left.

proximal to the preserved valve in the remaining PV segment after SFPV harvest.

## METHODS

Forty-four SFPVs harvested from 39 cadaveric specimens were used for data analysis. In five cases, the SFPVs were harvested bilaterally, whereas the remainder were harvested from the right leg. Excluded from the study were cases with previous leg or knee trauma (including operative procedures) or SFPV segments that had been damaged during preservation.

The SFPV was carefully exposed through a medial leg incision from its junction with the PFV to the origin of the PV at the entry of the anterior tibial vein. After exposure, all significant collateral veins (more than 2 mm, confirmed by means of the outside diameter measurements) in the PV were identified, preserved, and photographed (Fig 1). The location of the collateral veins was measured in the PV as the distance from the inferior edge of the adductor hiatus to the collateral vein (Fig 2). SFV length was measured from the SFV/PFV confluence to the inferior edge of the adductor hiatus, and PV length was measured from the inferior edge of the adductor hiatus to the entry of the anterior tibial vein.

The SFPV was then opened along its entire length, the luminal surface was washed with water, and valves within the PV were identified and photographed (Fig 3). Valve locations in the PV were recorded as distances from the inferior edge of the adductor hiatus.

The Student two-tailed *t* test was used as a means of comparing "anatomic safe vein lengths" between the sexes, and nonparametric correlation coefficients were determined to compare the effect of cadaver height on vein lengths stratified by means of sex (SPSS 9.0, Chicago, Ill).

## RESULTS

Forty-four SFPVs were harvested from 39 cadaveric specimens, 13 male (mean height, 170 cm) and 26 female (mean height, 150 cm; Fig 4). All measurements are recorded in Table I. A comparison of right and left vein lengths was performed by using a paired two-tailed *t* test in five cadavers (Table II), and no difference was found between the two limbs ($P = .9$).

Both SFV and PV lengths and distances to valve and collateral branch locations in the PV

Table I. Summary of superficial femoral vein and popliteal vein lengths and distances to valves and branches

| | Average anatomic safe length | Anatomic safe length of PV | SFV length | PV length | PV branch total |
|---|---|---|---|---|---|
| Men<br>N = 13, average height, 170 cm | 50 cm* | 15 cm* | 28.1 ± 5.0 cm* | 21.5 ± 3.0 cm* | 5.7 ± 3.0 |
| Women<br>N = 26, average height, 150 cm | 40 cm* | 12 cm* | 22.6 ± 4.0 cm* | 18.4 ± 3.0 cm* | 4.6 ± 1.0 |
| Total<br>N = 39 cadavers<br>N = 44 SFPVs | — | — | 24.4 ± 4.0 cm | 18.8 ± 4.0 cm | 5.0 ± 1.8 |

*$P < .01$ with a two-tailed $t$ test when comparing men with women.
*SFV,* Superficial femoral vein; *PV,* popliteal vein; *SFPVs,* superficial femoral popliteal veins.

Table II. A comparison of right and left popliteal vein lengths (in centimeters) in five cadavers ($P = .9$)

| Patient | Right | Left | Difference |
|---|---|---|---|
| 1 | 22.1 | 20.6 | 1.5 |
| 2 | 24.5 | 24.0 | 0.5 |
| 3 | 14.2 | 15.9 | 1.7 |
| 4 | 23.1 | 22.6 | 0.5 |
| 5 | 18.1 | 19.5 | 1.4 |

were dependent on patient sex and independent of patient height. SFV and PV lengths were found to be significantly different between men and women ($P < .01$). Men had an average SFV length of 28.1 ± 5 cm and a PV length of 21.5 ± 3 cm, whereas women had an average SFV length of 21.5 ± 3 cm and a PV length of 18.4 ± 3 cm (Table I). Nonparametric correlations were performed to determine the effect of height on vein length. No significant correlations were found between height and vein lengths when analyzed by means of sex (women R, 0.128; $P = .53$; men R, 0.40; $P = .20$). Overall, the average anatomic "safe" vein length of the SFPV in men is 50 cm, and the average anatomic "safe" vein length of the SFPV in women is 40 cm. The anatomic "safe" length of the PV at a 95% CI level is 15 cm in men and 12 cm in women (Table I). The 95% CI level is the vein length at which the longest length can be harvested in 95% of the population while still leaving one valve and one collateral branch intact.

## DISCUSSION

The SFPV has been used as a conduit for in situ reconstruction after removal of infected prosthetic aortic grafts, lower-extremity bypass grafting, and major venous reconstruction.[1-5] Excellent patency rates for reconstructions with the SFPV are reported,[1-5] but a hesitancy about its use remains because of the potential for significant venous morbidity after its harvest. Significant variation in venous morbidity, from minimal to debilitating pain and swelling, after SFPV harvest has been reported.[6-9] Further examination of these reports reveals that there is no accepted standard of care for the length of vein harvested, preoperative venous evaluation (including evaluation for valvular competence and functional venous testing), or standard perioperative care. Differences in care may account for the variation in reported morbidity after SFPV harvest, and therefore, a clinically "safe" length of SFPV for harvest has yet to be determined.

Other interventions or pathologic conditions of the SFPV may shed light on a "safe" length for harvest. SFV ligation has been used to prevent pulmonary emboli from the lower extremity. The procedure fell into disfavor because of several reasons, including reports that SFPV ligation causes elevated venous foot pressures and the demonstration of a high rate venous ulceration by some investigators.[10-12] However, Masuda et al[13] reported a 13-year follow-up study in which SFV obstruction was demonstrated to be well tolerated with minimal morbidity, provided the PFV was patent. These findings suggest that earlier reports of significant morbidity after SFV ligation may be attributed to other factors, including incomplete diagnosis of the extent of venous disease (either PFV or proximal vein occlusion). Raju et al[14] reported on obstruction of the SFPV and demonstrated that there is no correlation between the anatomic locale, the extent of venous obstruction, or the venographic occurrence of collaterals and significant venous morbidity. They suggested there was an association

| *Distance to first PV branch* | *Distance to last PV branch* | *PV valve total* | *Distance to first PV valve* | *Distance to last PV valve* |
|---|---|---|---|---|
| 3.9 ± 3.0 cm | 15.4 ± 4.0 cm | 1.8 ± 0.6 | 5.1 ± 4.0 cm | 16.8 ± 3.0 cm |
| 2.7 ± 3.0 cm | 13.0 ± 4.0 cm | 1.8 ± 0.5 | 7.4 ± 5.0 cm | 13.8 ± 4.0 cm |
| 3.1 ± 3.0 cm | 14.0 ± 4.0 cm | 1.8 ± 0.5 | 7.0 ± 5.0 cm | 14.1 ± 3.0 cm |

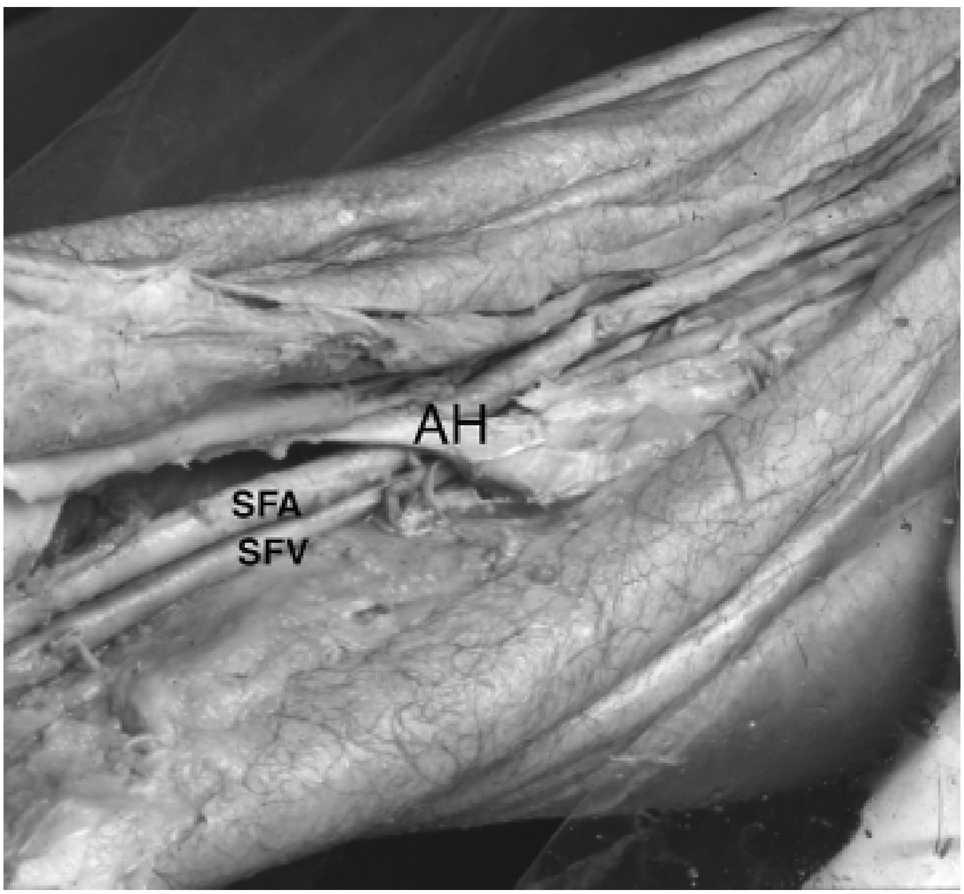


Fig 2. Cadaveric dissection of the popliteal artery and popliteal vein as they emerge from the adductor hiatus. The groin is to the right, and the knee is to the left.

between venous morbidity and the degree of venous reflux. These observations suggest that venous morbidity associated with ligation / obstruction of the SFPV is multifactorial in origin and may be related to both obstruction and reflux, and that harvest of the SFV alone without proximal obstruction and with a patent PFV is free of significant venous morbidity.

We assume that an important factor in reducing venous morbidity after obstruction is the presence of significant collateral veins between the PV and the

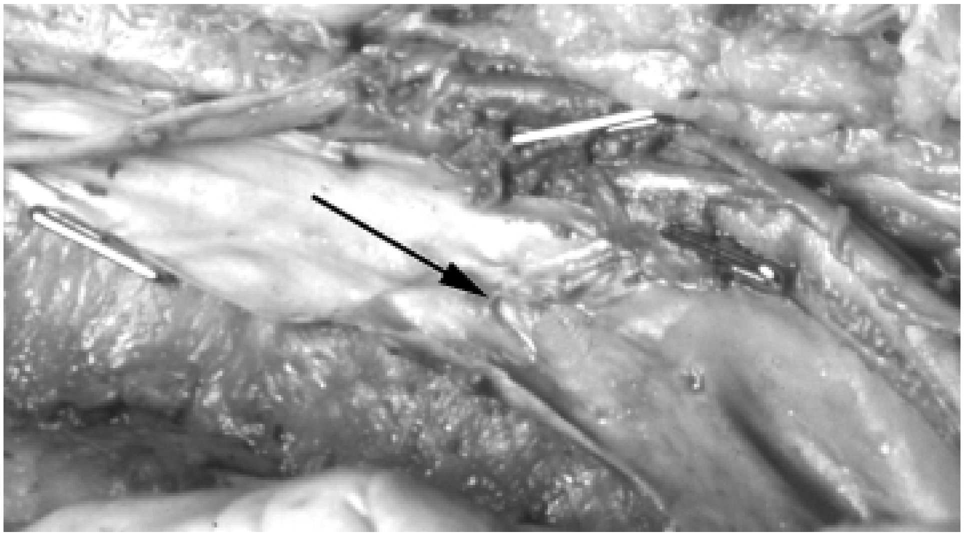

Fig 3. Close-up of cadaveric dissection of a valve (*arrow*) in the popliteal vein. The groin is to the right, and the knee is to the left.

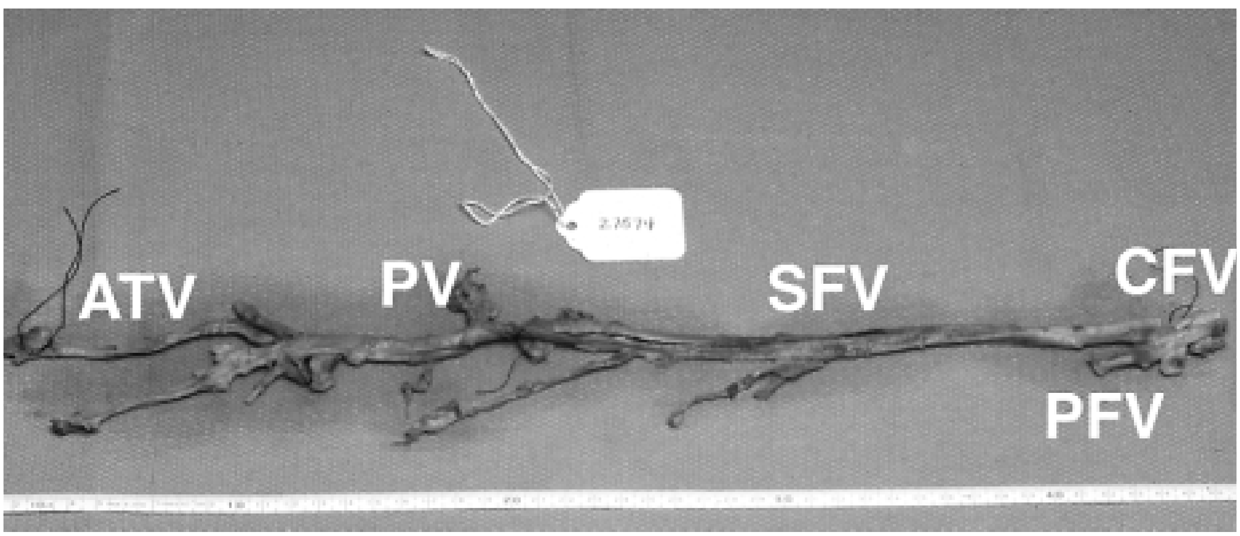


Fig 4. Cadaveric specimen of deep veins of the legs: the common femoral vein, profunda femoris vein, superficial femoral vein, popliteal vein, and anterior tibial vein.

PFV.[15] Mavor and Galloway described the venous anatomy of the lower extremity, with particular attention to collateral venous channels.[16] They found that in more than 90% of specimens they could demonstrate a communication between the PV or venae comitantes of the popliteal artery and the common femoral or PFV. The role of collateral veins in preventing venous morbidity after SFPV harvest was further supported by Wells et al, who reported minimal clinical morbidity after SFPV harvest.[6] In this study, patients were examined with lower-extremity duplex scanning after SFPV harvest, and a constant finding was the presence of collateral veins between the PV stump and the PFV, which the authors felt were important in the prevention of significant venous morbidity. These data suggest that a patent PV with a collateral network to the PFV or common femoral vein is important in preventing venous morbidity after SFPV harvest.

Given the conflicting reports of minimal or significant venous morbidity and the variety of reporting methods, it is difficult to determine a "safe" length of

SFPV for harvest. However, considering these data, we conclude that venous morbidity associated with SFPV harvest is probably not dependent on the harvest of the SFV, but more likely is caused by the harvest of the PV and is associated with two factors: significant reflux disease in the veins remaining after SFPV harvest and the absence of collateral veins from the PV to the PFV or common femoral vein. Therefore, we define an anatomic safe length of SFPV for harvest as a length that would leave one valve in the distal PV stump (to prevent reflux) and one significant collateral vein (more than 2 mm in diameter) in the PV stump superior to the valve. Although our study evaluates the anatomic safe vein length, the basis for which we perform SFV / PV harvest should be a thorough anatomic study. Clinical correlation studies are necessary to determine whether these anatomic safe vein lengths are functionally safe.

Our data were analyzed in relation to height and sex. Height data were obtained from the medical records of the patients before death. In examining the data, we found that the anatomic "safe" vein length was independent of height and dependent on sex.

In conclusion, the use of SFPV as an alternative conduit continues to expand. We have defined an anatomic "safe" vein length of SFPV for harvest to include one valve in the distal PV stump (to prevent reflux) and one significant collateral vein (more than 2 mm in diameter) in the PV stump superior to the valve. Given these criteria, 15 cm of PV in men and 12 cm of PV in women can be harvested distal to the inferior edge of the adductor hiatus with a 95% confidence of preserving at least one valve and one collateral vein. In our study, the average anatomic "safe" length of SFPV for harvest varied from 40 cm in women to 50 cm in men.

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