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Research Article

Anatomical Relationship of the Saphenous Nerve to Primary Great Saphenous Varicosity in the Legs of an Asian Population

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Abstract

Objective: In endoscope-assisted surgery for varicose veins, the anatomical relationship of the saphenous nerve to great saphenous varicosity in the leg was studied in an Asian population.

Methods: Primary varicose veins were managed using endoscope-assisted surgery.

Results: Between January 2007 and November 2015, 860 legs with primary varicose veins of the great saphenous vein (GSV) were managed. The saphenous nerve was encountered in the operative field in 82 legs (9.5%). The anatomical relationship of the nerve to the main trunk, tributaries, and incompetent perforating veins of great saphenous varicose vessels was evaluated and classified into 4 types, I, II, III, and IV, with incidences of 0.9%, 6.9%, 0.6%, and 1.2%, respectively. The incidences of the presence of this nerve in the upper, middle and lower thirds of the leg were 0.7%, 4.3% and 4.5%, respectively.

Conclusion: This study revealed the relative location and incidence of the saphenous nerve among the GS varicose vessels and the possible risk of nerve injury in the management of varicose veins of the GSV.

Keywords: *Saphenous Nerve; Great Saphenous Varicosity; Anatomical; Endoscope-Assisted Surgery; Asian Population*

Abbreviation

GSV: Great Saphenous Vein

Introduction

Injury to the saphenous or sural nerve is the most common medicolegal problem in the management of varicose veins [1,2]. However, the mechanism of nerve injury has not been determined to date. Critchley., *et al*. reported that the incidence of neurological disturbance was 6.6% [1]. Munn., *et al*. reported that the postoperative incidence of paresthesia was 33% in stripped limbs [3]. Rivlin recommended that the great saphenous vein (GSV) should be stripped from 4 cm below the tibial tubercle to the groin to decrease the incidence of par-

esthesia [4]. When radiofrequency ablation of the GSV was performed, the incidence of paresthesia ranged from 2.8 - 9.7%, which was reported from 31 sites worldwide [5]. Several investigations and methods attempted to minimize the incidence of nerve injury, but the true cause of this injury has not been elucidated to date [6,7].

Lin., *et al*. developed an endoscope-assisted surgery for the management of varicose veins [8-10] (see complementary video, https://drive.google.com/open?id=0B9GW1JJYL1niVi1BNE1xZGxaek0. This video demonstrates the endoscopic-assisted surgery for the management of varicose veins). The superior illumination and magnified monitor view provided by the surgical endoscope enables clear visualization and identification of tissues in the operative field, including normal veins, the varicose main trunk of the GSV, varicose tributaries, incompetent perforating veins, and saphenous nerve. The present study examined the anatomical position and presence of the saphenous nerve in the operative field. Whenever the saphenous nerve was not visible in the operative field under endoscopy, it was assumed that a certain distance existed between the saphenous nerve and the GSV. This anatomical evaluation examined the incidence of saphenous nerve injury, which was logically less likely.

Materials and Methods

The Institutional Review Board of Kaohsiung Medical University Chung-Ho Memorial Hospital approved the study protocol, and informed consent was obtained from all patients before enrollment. All methods were performed in accordance with the relevant guidelines and regulations of varicose veins surgery of the hospitals. The process and details of the management of primary varicose veins using endoscope-assisted surgery were described previously [11]. Preoperatively, varicose lesions were detected using inspection and palpation and marked with a marking pen after the patient stood upright for five to ten minutes to allow for venous filling and dilatation. The surgery was performed under general anesthesia. Before initiating the surgery, the limb was exsanguinated using an Esmarch bandage and subsequently maintained using a tourniquet. The access wound was an incision (2.5 cm in length) of the skin overlying the varicose vessels. Initially, an optical space was created with sufficient space for the insertion of the retractor-mounted endoscopic system and maneuvering of surgical instruments. CO_2 insufflation was not applied during dissection. Depending on the extent and location of the varicose lesion, additional strategic incisions were made. Due to the location of the varicose main trunk, tributaries, and incompetent perforating veins in the suprafascial layer, the surgery proceeded only suprafascially.

Under the clear illumination and magnified monitor viewing of the endoscope, non-varicose and varicose vessels were readily identified in the operative field [9]. The gross appearances of non-varicose veins were straight, constricted and shiny, as opposed to tortuous or flaccid. The saphenous nerve was also identified in the operative field as a straight whitish stripe frequently with a delicate nutrient arteriole on the surface. The varicoses of the main trunk, tributaries, and incompetent perforating veins were dissected delicately from the subcutaneous tissue. All varicose vessels that were preoperatively marked in the skin were dissected completely. The transitional zone between the varicose and non-varicose vessels was clipped and divided, and the non-varicose veins were preserved. The incompetent perforating veins, which were found and identified as they penetrated the fascia and were dissected, clipped, and divided. If the saphenous nerve and its branch were present during the operative procedure, these structures were delicately freed from surrounding tissues and preserved. The nerve was preserved and freed from the complicated varicose cluster, often without ease. All of the varicose vessels of the main trunk, tributaries, and incompetent perforating veins were removed after complete dissection and division.

The incision wound was closed primarily without insertion of a drainage tube. The leg was dressed using a firm bandage (Elastic Bandages®, iming@supports.com.tw). In general, patients were discharged the day after surgery. The operative wounds of the patients were cared for in the outpatient department.

Results

Between January 2007 and November 2015, 860 legs with primary GS varicose veins were managed using endoscope-assisted surgery. A total of 14 men and 68 women (39 left and 43 right legs), aged 20 - 84 years (mean age, 55.1 years), were examined (Table 1). The saphenous nerve was noted in the operative field in 82 legs (9.5%). This nerve was noted in the operative fields in the upper-, middle-, and distal-thirds of 6 (0.7%), 37 (4.3%), and 39 (4.5%) legs, respectively (Table 2).

	No.
Cases of GS varicose veins	860
Cases of saphenous nerve identification	82
Men	14
Women	68
Left leg	39
Right leg	43
Age range, 20 - 84 years; mean age, 55.1 years	

Table 1: *Patient characteristics.*

Location	Number	Percentage (%)
Upper-third of the leg	6	0.7
Middle-third of the leg	37	4.3
Lower-third of the leg	39	4.5

Table 2: *Number and percentage of saphenous nerve identification in the operative field (n = 860).*

Incompetent perforating veins were not present in the operative field in 20 legs. In the remaining 62 legs, these veins were observed in the upper, middle, and lower thirds of 1, 28, and 33 legs, respectively (Table 3). The only perforating vein in the upper third of the leg was identified as the medial gastrocnemius perforating vein. Five posterior tibial upper perforating veins, 22 paratibial veins, and one medial gastrocnemius incompetent perforating vein were observed in the middle third of the leg. In the lower third of the leg, 14 posterior tibial lower perforating veins, 18 posterior tibial middle perforating veins, and 1 medial gastrocnemius perforating vein were noted (Table 3). An incompetent perforating vein and its tributary might be connected to the main trunk in the middle and lower thirds of the leg, which resulted in the construction of various forms of varicose clusters. The 82 saphenous nerves identified in the operative field were classified into four types depending on the relationship of the nerve with the perforating vein, tributaries, and main trunk (Table 4):

	Medial gastrocnemius	Lower paratibial	Posterior tibial lower perforating	Posterior tibial middle perforating	Posterior tibial upper perforating	Total
Upper-third of the leg	1	0	0	0	0	1
Middle-third of the leg	1	22	5	0	0	28
Lower-third of the leg	1	0	0	18	14	33
*Synonym: Posterior tibial lower perforating (Cockett I), Posterior tibial middle perforating (Cockett II), Posterior tibial upper perforating (Cockett III).						

Table 3: *Presence of incompetent perforating veins in the upper-, middle-, and lower-thirds of the leg (62 legs).*

Type	No.	%
I	8	0.9
II	59	6.9
III	5	0.6
IV	10	1.2
Total cases	82	9.5
(n = 860 varicose vein cases)		

Table 4: *Number and percentage of the four types of relative locations of the saphenous nerve to the great saphenous varicose vessels.*

- Type I (8 legs, 0.9%; Figure 1): The saphenous nerve was located posteriorly or parallel to the main trunk of the GSV. No nearby incompetent perforating vein or varicose tributary was detected. Loose fibrous adhesions were noted between the nerve and the main trunk.
- Type II (59 legs, 6.9%; Figure 2): The saphenous nerve passed beneath the varicose cluster. The nerve was identified only after the varicose tributaries, incompetent perforating veins, or main trunk were dissected and separated. Nearby incompetent perforating veins were noted in 48 legs. Frequently, the dilated varicose main trunk or tributary compressed the nerve and was adherent to surrounding tissues.
- Type III (5 legs, 0.6%; Figure 3): The saphenous nerve passed anteriorly across the varicose cluster. The clusters all had an underlying incompetent perforating vein and varicose tributary. Adhesion was observed between the nerve and the underlying varicose veins.
- Type IV (10 legs, 1.2%; Figure 4): Two branches of the saphenous nerve were observed. The branches of the saphenous nerve crossed the varicose cluster in four legs. In another four legs, both nerve branches descended closely along both sides of the main trunk. In the remaining two legs, both branches passed posteriorly to the main trunk. An incompetent perforating vein was present in six of the 10 legs.

Case Presentation

Case 1 (Type I [Figure 1]): This case was a 66-year-old woman with left varicose veins (C2EpAsPr). Varicose lesions were marked preoperatively. The intraoperative view of the saphenous nerve after the main trunk was dissected and pushed laterally is described in a schematic figure (Figure 1a), which shows the intraoperative identification of the main trunk and the aforementioned saphenous nerve. The varicose main trunk was excised, and the nerve was separated and preserved. The varicose vessels were excised in their entirety. The non-varicose main trunk of the middle third of the leg was preserved. The fine yellowish rod, seen in figure 1b, represents the location of the saphenous nerve in relation to the main trunk. No sign of nerve injury or recurrence of varicose veins was observed at 12 months postoperatively.

Case 2 (Type II [Figure 2]): This case was a 65-year-old woman with right varicose veins (C2EpAsPr). Varicose lesions were marked preoperatively. Intraoperative view revealed the saphenous nerve under the tributary, which connected the main trunk and the incompetent perforating vein. The schematic figure (Figure 2a) shows the intraoperative identification of the aforementioned main trunk, tributary, incompetent perforating vein, and saphenous nerve. The tributary and perforating vein were dissected and divided, and the underlying

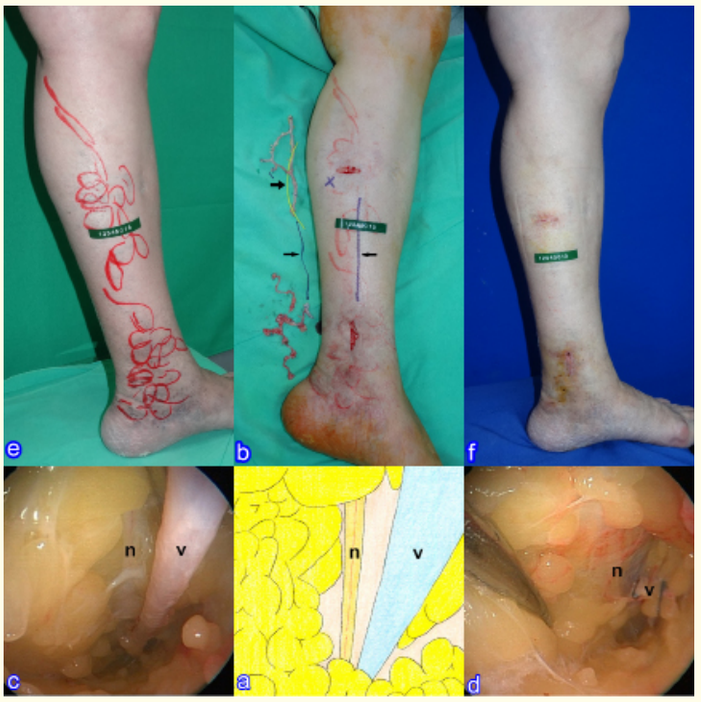

Figure 1: *Case 1. (a) Schematic illustration of the intraoperative findings in figure 1c. (b) The varicose veins were totally excised. The yellowish rod (heavy →) represents the saphenous nerve. The non-varicose main trunk (blue line, light →) was preserved. (c) Intraoperative view of the dilated main trunk (v) and the saphenous nerve (n). (d) The distal stump of the excised dilated main trunk (v). The saphenous nerve was preserved (n). (e) Preoperative view of the left lower limb. The varicose lesions were marked. (f) Postoperative view 19 days later.*

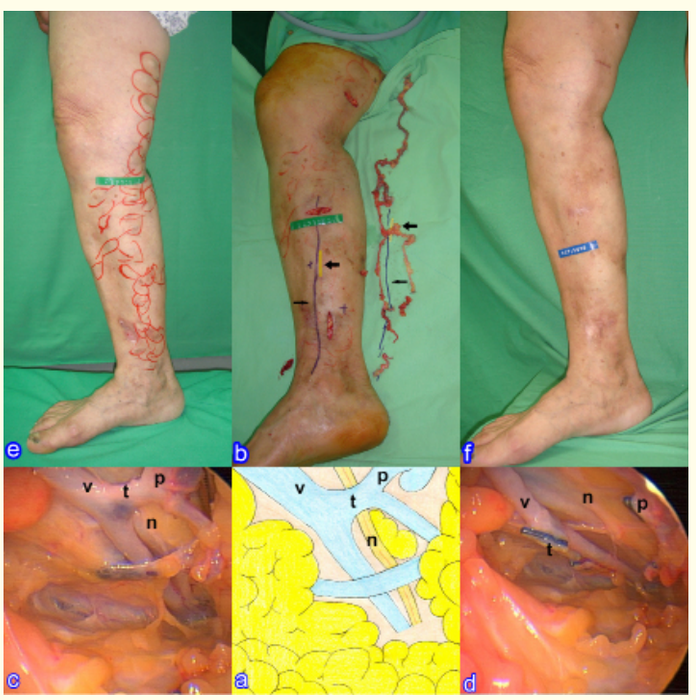

Figure 2: *Case 2. (a) Schematic illustration of the intraoperative findings in figure 2c. (b) The varicose veins were totally excised. The yellowish rod represents the preserved saphenous nerve (n) (heavy →). The non-varicose main trunk (blue line) was preserved (light →). (c) Intraoperative view of the varicose main trunk (v), perforating vein (p), tributary (t), and saphenous nerve (n). These vessels formed a varicose cluster. (d) Exposed saphenous nerve (n), divided tributary (t), and perforating vein (p). (e) Preoperative view of the right lower limb. The varicose lesions were marked. (f) Postoperative view 5.5 months later.*

nerve was exposed and preserved. The varicose veins were excised in entirety. The non-varicose main trunk in the distal two thirds of the leg was preserved. The fine yellowish rod seen in figure 2b represents the saphenous nerve in relation to the varicose cluster. No nerve injury or recurrence of varicose veins was noted at 5.5 months postoperatively.

Case 3 (Type III [Figure 3]): This case was a 59-year-old man with left varicose veins (C2EpAsPr). Varicose lesions were marked preoperatively. The intraoperative view showed the saphenous nerve crossing superiorly to the main trunk, and a nearby perforating vein was noted. The schematic figure (Figure 3a) shows the intraoperative identification of the aforementioned saphenous nerve, main trunk, and perforating vein. The perforating vein was dissected and divided, and the nerve was delicately freed from the underlying varicose cluster and preserved. The varicose posterior arch vein and its tributaries were radically excised, and the non-varicose main trunk was preserved. The fine yellow rod, seen in figure 3b, represents the nerve in relation to the main trunk. No nerve injury or recurrence of varicose veins was observed at 113 months postoperatively.

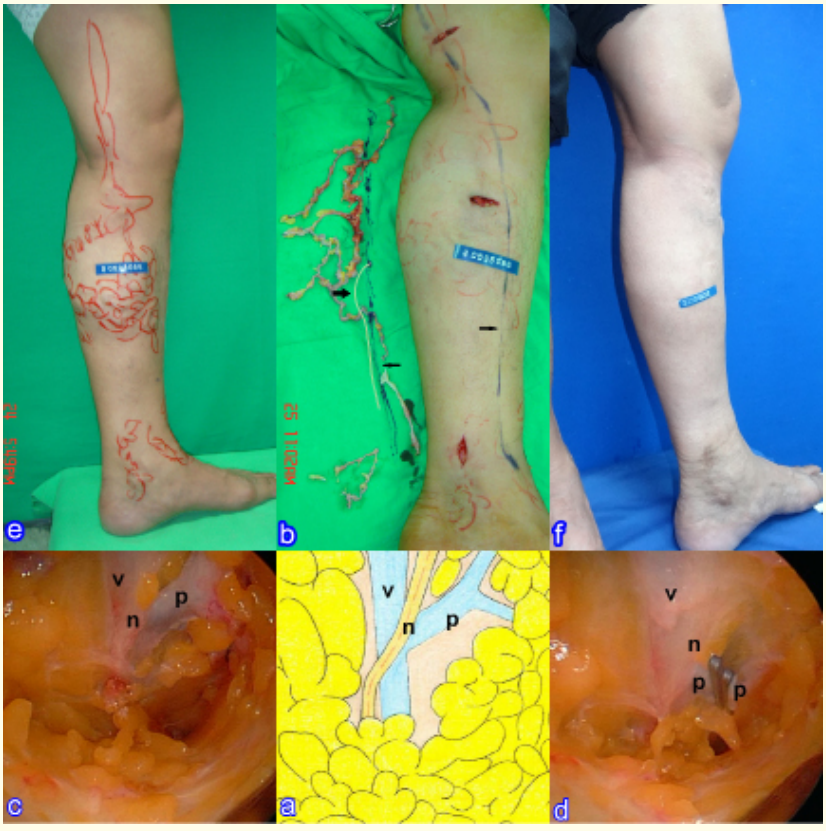

Figure 3: *Case 3. (a) Schematic illustration of the intraoperative findings in figure 3c. (b) The varicose veins were totally excised. The yellowish rod represents the saphenous nerve (heavy →). The non-varicose main trunk (blue line, light →) was preserved. (c) Intraoperative view of the varicose main trunk (v), saphenous nerve (n), and perforating vein (p). These vessels formed a varicose cluster. (d) The divided end of the perforating vein (p). (e) Preoperative view of the left lower limb. The varicose lesions were marked. (f) Postoperative view 113 months later.*

Case 4 (Type IV [Figure 4]): This case was a 57-year-old woman with right varicose veins (C2EpAsPr). Varicose lesions were marked preoperatively. The intraoperative view demonstrated that the branched nerves were dissected from the right and left sides of the main trunk. The schematic figure (Figure 4a) shows the intraoperative identification of the aforementioned main trunk, perforating vein, and branched nerves. The main trunk and incompetent perforating vein were divided and excised, and the branches of the nerve were dissected and preserved. The varicose veins were radically excised. The distal two fifths of the non-varicose main trunk were preserved. The fine yellow rods, as seen in figure 4b, demonstrates the location of the nerve in relation to both sides of the main trunk. No nerve injury or recurrence of varicose veins was observed at 96 months after surgery.

Figure 4: *Case 4. (a) Schematic illustration of the intraoperative findings in figure 4c. One branch (n1) crossed over superiorly on the perforating vein. (b) The varicose veins were totally excised. The yellowish rod represents the nerve branches (heavy →). The distal two fifths of the non-varicose main trunk (blue line, light →) was preserved. (c) Intraoperative view of the varicose main trunk (v), perforating vein (p), and branches of the saphenous nerves (n1 and n2). These vessels formed a varicose cluster. (d) The perforating vein was divided (p). The main trunk was divided (v) and excised. The nerve branches (n1 and n2) were freed and preserved. (e) Preoperative view of the right lower limb. The varicose lesions were marked. (f) Postoperative view 96 months later.*

Discussion

The location of the saphenous nerve in relation to the great saphenous varicose vessels is a critical factor for nerve injury in the management of great saphenous varicose veins. The anatomical relationship between the saphenous nerve and the long saphenous vein in the general population was reported previously [12,13]. The frequency of injury to the saphenous nerve by performing classic downward stripping was 27% compared to 50% in upward stripping [12,13]. However, these data do not reveal the possible risk or mechanism of nerve injury during stripping.

The incidence of the presence of the saphenous nerve in the operative field was only 0.7% in the upper-third of the leg. In these cases, the saphenous nerve was located posteriorly to the main trunk of the GSV. Only one nearby medial gastrocnemius incompetent perforating vein was detected. Therefore, the possibility of nerve injury during the management of GSV varicose veins in this area was correspondingly low. These data correlate with the surgical strategy of a safe level of stripping. Holme., *et al*. reported that the incidence of saphenous nerve injury after partial stripping of the GSV from the groin to ankle was 39% versus only 7% after the GSV was partially stripped to 4 cm below the knee [14]. Creton used tumescent anesthesia in invagination, which may have helped widen the close proximity and avoid nerve injury [7].

The incidence of the presence of the nerve in the operative field in the middle and lower thirds of the leg increased to 4.3% and 4.5%, respectively. The number of incompetent perforating veins in these areas also increased to 28 and 33, respectively. The presence of incompetent perforating veins may result in the formation of a varicose cluster with the main trunk and nearby tributaries. The tissue reaction to venous hypertension in this cluster involves the induction of fibrosis and adhesion of the nerve to the varicose vessels and surrounding tissues. In these situations, the saphenous nerve was adhered to the complicated varicose cluster. During conventional stripping or phlebectomy, the nerve is torn off during the process, even when radiofrequency ablation was performed to treat varicose vein for this varicose cluster. These legs are highly susceptible to nerve injury. Therefore, the possibility of nerve injury is high (8.8%) in the management of the primary GS varicose veins of the lower two thirds of the leg. In the current series, the encountered saphenous nerves were delicately freed from the varicose cluster and preserved during endoscope-assisted surgery. Therefore, nerve injury was avoided. No case of permanent nerve injury was noted during follow-up. Temporary paresthesia was observed in five cases, all of which recovered spontaneously within four months.

The limitations of this study are that all of the patients were Chinese, and only the nerve encountered in the endoscopic operative field during endoscope-assisted surgery was evaluated. The absence of this nerve in the other cases (90.5%) suggests a distance between the varicose vein and the nerve. The incidence of nerve injury was low in this situation. Therefore, the close relationship between GS varicose veins and the saphenous nerve requires further research.

Conclusion

The relationship of the saphenous nerve with the main trunk, tributaries, and perforating veins of GS varicose veins in an Asian population was demonstrated in this study. The findings provide relevant and valuable anatomical data to elucidate the mechanism of nerve injury in the management of varicose veins within the GSV territory.

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Conflict of Interest

There are no conflicts of interest in this study.

Bibliography

1. Critchley G., *et al*. "Complications of Varicose Vein Surgery". *Annals of the Royal College of Surgeons of England* 79.2 (1997): 105-110.

2. Scurr J. "Complications in the Treatment of Varicose Veins". *AMVA Medical and Legal Journal* 1 (1990): 1-3.

3. Munn SR., *et al*. "To Strip or Not to Strip the Long Saphenous Vein? A Varicose Veins Trial". *British Journal of Surgery* 68.6 (1981): 426-428.

4. Rivlin S. "The Surgical Cure of Primary Varicose Veins". *British Journal of Surgery* 62.11 (1975): 913-917.

5. Merchant RF., *et al*. "Endovascular Obliteration of Saphenous Reflux: A Multicenter Study". *Journal of Vascular Surgery* 35.6 (2002): 1190-1196.

6. Sam RC., *et al.* "Nerve Injuries and Varicose Vein Surgery". *European Journal of Vascular and Endovascular Surgery* 27.2 (2004): 113-120.

7. Creton D. "[The Results of Internal Saphenous Vein Stripping under Local Anesthesia in Outpatient Care (700 Cases)]". *Phlebologie* 44.2 (1991): 303-311.

8. Lin SD. "Endoscope-Assisted Management of Primary Varicose Veins of the Long Saphenous Vein and Its Tributaries". *Phlebology* 19.1 (2004): 35.

9. Lin SD., *et al*. "Gross Anatomy of Primary Varicose Veins Observed in Endoscopic Surgery". *Annals of Plastic Surgery* 49.6 (2002): 559-566.

10. Lin SD., *et al*. "Endoscope-Assisted Management of Varicose Veins in the Posterior Thigh, Popliteal Fossa, and Calf Area". *Annals of Plastic Surgery* 48.1 (2002): 10-20.

11. Lin SD., *et al*. "Endoscope-Assisted Correction of Primary Varicose Veins". *Annals of Plastic Surgery* 44.3 (2000): 241-249.

12. Holme JB., *et al*. "The Anatomic Relationship between the Long Saphenous Vein and the Saphenous Nerve. Relevance for Radical Varicose Vein Surgery". *Acta Chirurgica Scandinavica* 154.11-12 (1988): 631-633.

13. Ramasastry SS., *et al*. "Anatomy of the Saphenous Nerve: Relevance to Saphenous Vein Stripping". *The American Journal of Surgery* 53.5 (1987): 274-277.

14. Holme JB., *et al*. "Incidence of Lesions of the Saphenous Nerve after Partial or Complete Stripping of the Long Saphenous Vein". *Acta Chirurgica Scandinavica* 156.2 (1990): 145-148.

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