

Principles of Reconstructive Procedures for Chronic Femoro-popliteal Occlusions:

Report on 546 Operations

J. VOLLMAR, M.D., M. TREDE, B.A., M.D., B.CHIR., K. LAUBACH, M.D.,
H. FORREST, M.B., F.R.C.S.

From the Surgical Clinic of Heidelberg University, Heidelberg, Germany

THE HUMAN femoral artery is the most frequent site of obliterative vascular disease. After 20 years of surgical endeavor, the discussion is still in progress between the respective advocates of "patching," "grafting" and "stripping," concerning operative methods in this field. The following paper, based on experiences with 546 reconstructive procedures, attempts to present a survey of the indications, technics and results of this segment of vascular surgery.

I. Etiology and Morphology

Table 1 shows that obliterative arteriosclerosis ranks first amongst etiologic factors followed by endangiitis obliterans. Cystic degeneration of the adventitia, affecting mainly the first segment of the popliteal artery, is an extreme rarity.^{16, 22, 29}

Morphologically we distinguish 3 types of occlusion (Fig. 1).

- 1) Segmental occlusion (incidence: 20%)
- 2) Lengthy occlusion (incidence: 60%)
- 3) Transitional type (incidence: 20%)

Segmental occlusions are most commonly found in the distal part of the superficial femoral artery as it traverses Hunter's canal.

Unfortunately many occlusions that appear arteriographically well localized show extensive proximal and distal intimal degeneration at operation. These belong of course to the transitional group. Warren³⁸ has shown that the disease tends to progress in a centripetal direction until the final stage of a lengthy superficial femoral occlusion is reached. The occlusion almost invariably halts at the origin of the deep femoral artery, which functions as the most vital collateral vessel and may double its caliber. The fact that some 30 to 40% of femoro-popliteal occlusions are accompanied by similar lesions in the calf³⁶ carries great significance for the surgical indications.

Age and Sex Incidence

In our experience the average age of patients is 53 years; the youngest was 16, the eldest 73 years of age. The predominance of the male sex is evident: 512 men as against nine women.

II. Prognosis

The *prognosis quoad vitam* is primarily dependent on concomitant disease (coronary, cerebral or renal arterial insufficiency, hypertension and diabetes). Large statistical studies show that 10 years after the onset of symptoms, about 50% of patients are still alive.^{2, 5, 18} The more peripheral the occlusion, the greater is the threat to the

Submitted for publication September 19, 1967.

TABLE 1. Results of Histological Examination of 479 Operated Femoro-popliteal Occlusions*

Type of Occlusion	No.	%
Arteriosclerosis	374	78.0
Endangiitis obliterans	98	20.5
Traumatic thrombosis	6	1.3
Cystic adventitial degeneration	1	0.2
Total	479	100

* The histological examinations were performed by the Institute of Pathology, Heidelberg University. (Director: Prof. Dr. W. Doerr.)

TABLE 2. Triple-point-program for Operative Indications

<i>Clinical indication</i>	
Objective symptoms and signs of arterial insufficiency.	
Stage I	no indication
Stage II (intermittent claudication)	relative indication
Stage III and IV (rest-pain and distal necroses)	absolute indication
<i>Angiographic indication</i>	
Local operability depends on localization and extent of the arterial occlusion; patency of the proximal and distal vascular segments (free run-in and run-off).	
<i>General operability</i>	
Exclusion of multiple risk factors (hypertension, coronary, arterial disease; diabetes; excessive adiposity).	
Exclusion of other debilitating diseases.	

TABLE 3. Complications of Semi-closed Thromboendarterectomy of the Femoro-popliteal Segment (399 Operations)

Technical failure (stripping proved impossible)	31	(7.7%)
Perforation	11	(2.7%)

limb and the less is the life of the patient in danger.

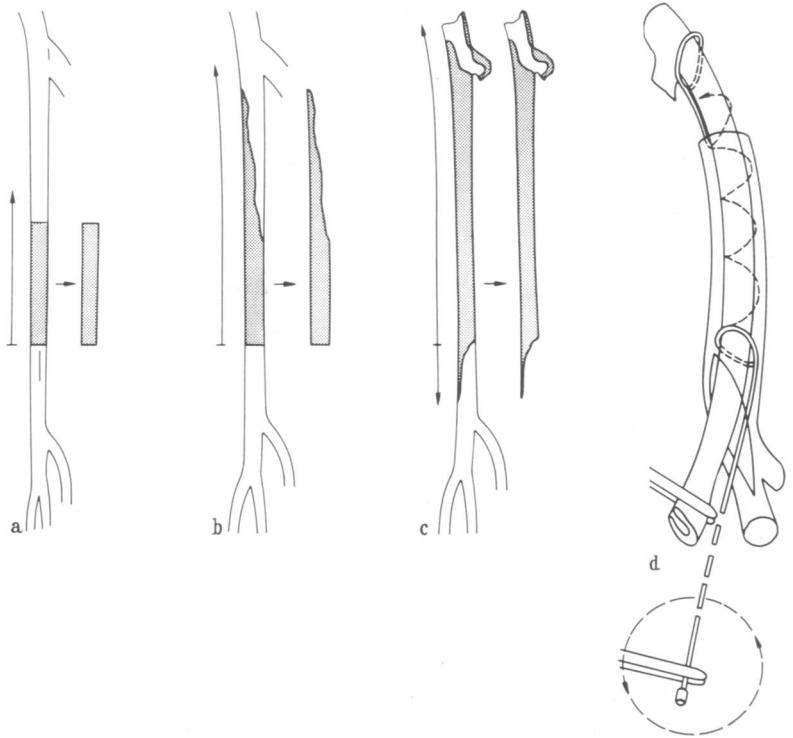
The *prognosis quoad extremitatem* is difficult to determine for the single case. In the natural course of the disease segmental occlusions may remain stationary for decades, but in about a third of patients superimposed arterial thrombosis may lead to a sudden exacerbation.¹⁷ On the average 7% of patients lose the affected limb within 5 years after the onset of symptoms, 10 to 15% suffer amputations within 10 years.⁴⁰

III. Indications for Operation

The indications for reconstructive operations on the femoro-popliteal vessels depend on certain local and general conditions summarized by a *triple-point-program* (Table 2). From the clinical point of view the indication for operation is dependent on the presence of symptoms and signs of arterial insufficiency. Most vascular surgeons agree that stage III and IV of the disease rank as absolute indications: the limb is immediately threatened by amputation and reconstruction of the arterial passage is considerably more effective than any indirect measure (lumbar sympathectomy; intraarterial infusions). In the case of stage II (intermittent claudication) we advise operation only if the patient's professional and personal activity is considerably curtailed, i.e., if the pain-free walking distance amounts to less than 600 yards. In the femoro-popliteal segment there is no place for prophylactic operations on well-compensated occlusions (stage I) since the natural course of the disease cannot be improved significantly in this group by operation.

The angiographic indication covers the evaluation of the arterial tree proximal and distal to the occlusive lesion. Optimal conditions with free run-in and run-off are seldom fulfilled. On the other hand the rule that local operability depends on the presence of at least 2 patent arteries below the knee, must be interpreted with flexibility. In stages III and IV an attempt at reconstruction is justifiable, especially if the limb has a high functional value (e.g., following amputation of the contralateral leg). In 38 such *inoperable* situations we were able to reconstruct the femoro-popliteal segment (often combining this with lumbar sympathectomy) with long-term favorable results in 55% of cases (return from stage III or IV into stages I and II). These *angiographically inoperable* cases are not included in the present series.

FIG. 1. Morphological types of femoro-popliteal arterial occlusions and the principle of their treatment by means of semi-closed thromboendarterectomy. a) and b) Segmental and transitional occlusions and their correction by retrograde spiral dissection from a single distal arteriotomy, c) Lengthy occlusion and its removal from a distal and proximal arteriotomy, d) The technic of semi-closed thromboendarterectomy: rotation of the blunt oblique dissecting ring occurs with spiral dissection of the occlusive cylinder.



Turning to the criteria of general operability it should be remembered that reconstructive procedures on this segment carry a relatively low operative risk (primary operative lethality less than 1%). Thus contraindications due to concomitant renal, cerebral or coronary arterial disease are not as significant as with the larger operations on the aorto-iliac vessels.

IV. Choice of Operative Procedure

The method of arterial reconstruction depends on the type and localization of the occlusion and all too often on the prejudice and personal experience of the vascular surgeon. The latter should however be flexible and familiar with the complete repertoire, since the final decision frequently cannot be made before the vessels are exposed and opened. The rate of recurrence is particularly high in the femoro-popliteal segment partly due to the small caliber of the vessels and frequently due to a poor run-off. It is therefore well not to

burn one's bridges at the first operation, but rather to leave an opening for possible second and third procedures.

1. Thromboendarterectomy

The method preferred for most types of occlusion is a semi-closed thromboendarterectomy. Certain technical improvements have made this procedure safe and effective (Figs. 1-3): a) the use of blunt, oblique rings, b) choice of a suitable plane of dissection (along the external or internal elastic lamina), and c) the principle of spiral dissection (by rotating the advancing oblique rings). In this way calcified plaques—often insuperable obstacles for transverse rings—can usually be threaded on to the ring and removed together with the intimal cylinder. Semi-circular blades, cutting-rings and spiral dissectors^{8, 20} tend to increase the danger of vessel perforation and should be avoided. The patency and smoothness of the remaining lumen is tested by introduction of another suitable

TABLE 4. Review of 546 Reconstructive Procedures on 521 Patients with Femoro-popliteal Occlusions (1/1/59-12/31/66)

Type of Operation	No. of Op.	No. of Deaths	No. of Follow-ups	Patent	Failures
Thromboendarterectomy	399	4[6]	389	333 + 27 (93%)	56 A:2/R:27
Alloplastic bypass (Dacron)	98	1[7]	90	30 + 10 (44%)	60 A:16/R:27
Autoplastic bypass (vein)	49	—	49	47 + 2 (100%)	2 A:0/R:2
Total	546	5[13]	528	449(85%)	118(23%)

[] = late deaths, R = successful reoperations, A = amputation

sized ringstripper, followed by flushing with a balloon syringe. Furthermore the removed intimal cylinder should be inspected for "completeness." In selected patients the results of thromboendarterectomy can be controlled by means of an intra-operative arteriogram or possibly by means of a flexible endoscope. This semi-closed method not only brings the technical advantage of simplicity and speed but also the biological one of leaving the artery intact within the surrounding tissues and blood-supply. Thus postoperative intimal regeneration is facilitated.¹³ Long-term anti-

coagulant prophylaxis (Dicoumarin; Quick-time: 15-25%) is begun on the third post-operative day.

a. Correction of Segmental Occlusions

The artery is exposed through a medial incision superior to the knee at the level of the distal end of the occlusion. The occlusive cylinder is dissected circumferentially through a longitudinal arteriotomy and then threaded onto a ring stripper. The latter is passed up in a retrograde direction along the preformed plane of dissection. The intimal cylinder breaks off at its junction with normal intima. The cylinder is removed in one piece and inspected for completeness. The stump of the distal and more normal intima is smoothed. "Blind" stripping in the orthograde direction is dangerous. If necessary pathologically thickened intima should be completely removed with the aid of a second more distal arteriotomy. The arteriotomy is closed by direct atraumatic suture or, if the arterial lumen is too narrow, by means of an autologous vein patch. The latter is taken from one of the branches of the saphenous vein—not from the main vessel itself.

b. Correction of Lengthy and Transitional Occlusions

Here thromboendarterectomy should be carried out in a retrograde fashion between

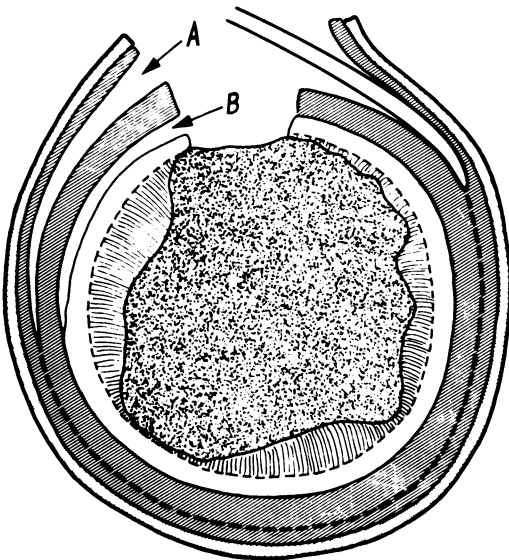
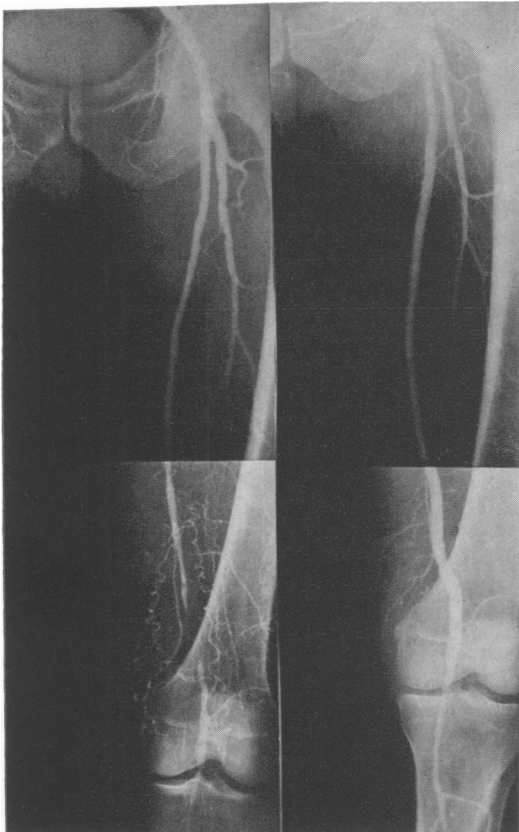


FIG. 2. Dissection planes of thromboendarterectomy. A. Along the external elastic lamina. B. Along the internal elastic lamina.



Pre-op.

Post-op.

FIG. 3. Segmental occlusion of popliteal artery. Left: preoperative angiogram; right: angiogram following semi-closed retrograde thromboendarterectomy.

anastomosis with the popliteal artery (Fig. 4). In our experience the "in-situ-bypass"¹³ brings several disadvantages (longer operating-time; uncertainty as to the destruction of all venous valves; potential arterio-venous fistulae) and is justified only in those rare cases, where the bypass has to be carried to the middle third of the calf.

V. Analysis of Results

This analysis comprises 546 reconstructive procedures performed for femoro-popliteal occlusions on 521 patients in the Surgical Clinic of Heidelberg University between 1/1/59 and 12/31/66 (Table 4). The indication for operation was furnished in 82% by intermittent claudication (stage

II) and in 18% by the presence of rest-pain or distal necrosis (stages III and IV) (Table 5). Up to the end of 1962 surgical reconstruction was almost exclusively performed by means of alloplastic bypass (woven or knitted Dacron). Thereafter autoplasmic procedures (semi-closed thromboendarterectomy in 81% and vein bypass in 17%) were preferred. Ninety per cent of these patients were seen at regular 6-12 monthly follow-up examinations. Written questionnaires were answered by almost all of the remainder.

Results of Treatment

Three hundred and fifty out of 389 thromboendarterectomies, i.e., 93%, resulted in patent vessels and freedom from symptoms; this figure includes 27 correc-

TABLE 7. Causes of Death in 18 Patients with Femoro-popliteal Reconstructive Operations

	No.	Early Death (in hosp.)	Late Death (fol. disch)
Complication of the underlying disease	7		
Myocardial infarct		2	2
Cerebrovascular accident		1	2
Local vascular complication	3		
Sepsis following gas gangrene		—	2
Sepsis following infection of prosthesis		—	1
Gastro-intestinal complications	3		
Dicoumarin-bleeding		—	1
Adhesion ileus following gut resection		—	1
Peritonitis (occlusion of inf. mes. art.)		1 ¹	
Other causes	5		
Uremia		—	1
Accident		—	1
Carcinoma		—	1
Pulmonary embolism		—	1
Sepsis following blood transfusion		1	—
Total	18	5	13

¹ = with simultaneous aorto-femoral bypass.

tions of recurrent occlusion. Forty-nine vein bypasses were followed by 2 recurrences, which were subsequently corrected successfully (Table 4). The results are far less favorable for the alloplastic bypass with only 44% patent transplants (a figure that includes 10 successfully reconstructed recurrent occlusions). Analysis of the three methods over the years clearly shows their relative efficacy (Table 6). After 5 years 70% of thromboendarterectomized arteries remain open as against only 22% of alloplastic transplants. A similar group of vein bypasses is not yet available. However, after 2 to 3 years some 96 to 100% of the transplants remain patent.

Operative Lethality

Five of the 521 patients died in the hospital following operation (operative lethality: 0.9%). A further 13 patients died in the subsequent years usually of causes related to the primary disease (Table 7).

Postoperative Complications (Table 8)

By far the commonest complication was that of recurrent occlusion. Immediate occlusions (within 48 hours of operation) are usually the result of some unrecognized mechanical obstructions (intimal dissection; faulty suture technic with narrowing of the lumen; kinked transplant, etc.). Immediate operative revision was successful in all 13 patients.

Early occlusions (within 12 months of operation) are also caused in most instances by some mechanical stenosis in the run-in- or run-off vascular segment.

Late occlusions (beyond the first postoperative year) are usually due to progression of the underlying atherosclerosis. It is our impression that here also the autoplasmic procedures run a more favorable course. Whereas late occlusion of an alloplastic transplant is a sudden event followed by immediate and catastrophic ischemia, the re-occlusion of thromboendarterectomized vessels occur more gradually,

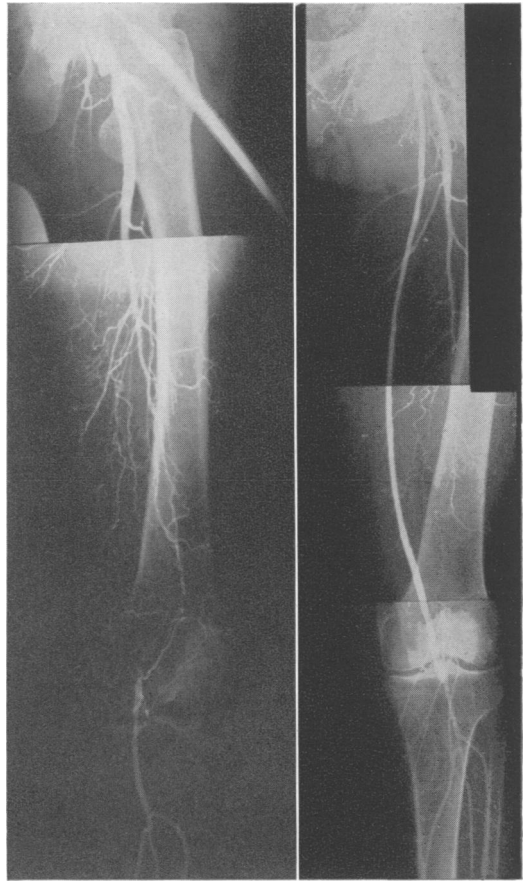


FIG. 4. Lengthy occlusion of superficial femoral artery down to the middle third of the popliteal artery. Semi-closed thromboendarterectomy proved technically impossible. Left: pre-operative angiogram; right: angiogram following reconstruction by means of an autoplasmic vein bypass.

so that there is time for collateral vessels to develop. In the past 3 years all late occlusions were operated upon as soon as possible, usually by means of a vein bypass.

Infection of a transplant or suture line constitutes the most serious postoperative complication (0.7%). Three of the four infections concerned Dacron prostheses. In one patient even massive antibiotic treatment could not prevent a fatal septicemia. An infected vein patch in the common femoral artery was successfully treated by means of an ilio-femoral obturator bypass.

Hemorrhage from non-infected wounds (5 cases) was due in 3 patients to technical

TABLE 8. Local Complications Following 546 Femoro-popliteal Reconstructions

Type of Complication	No.	Re-op.	Successful Re-op.	Amputation	±
Immediate occlusion (within 48-hr.)	13	13	13	—	—
Early occlusion (within 1 yr.)	77	23	23	12	—
Late occlusion (after 1 yr.)	42	15	15	5	1
Infection	4	1	1 ²	—	1
Anastomotic aneurysm	13 ¹	11	10	1	2
Hemorrhage	5	5	5	—	—

¹ = 1 × following vein interposition (popliteal artery)
12 × following Dacron bypass.

² = following thromboendarterectomy of femoral bifurcation with vein patch; treated by obturator bypass.

errors (loosening of a knot; slipping of ligatures from arterial branches) and twice due to a clotting disturbance (consumption coagulopathy).

Anastomotic *aneurysms* are a rarity since alloplastic transplants have been discarded. Twelve of the 13 aneurysms occurred at the sites of anastomoses with Dacron prostheses.

Amputation-Rate

Eighteen of the 546 operated limbs (i.e., 3.3%) were subsequently lost by crural or femoral amputation. Obviously the amputation rate was higher in stage IV cases (10.9%) than in stage II (2.2%) (Table 5); 8 of 10 amputations in the latter group were necessitated by occlusion of Dacron prostheses. With the exclusive application of autoplasmic procedures and immediate reoperation of all recurrent occlusions, the last 400 patients were free from such "iatrogenic" amputations. On the other hand, 83 of 100 limbs (in stages III and IV) imminently threatened by amputation could be fully revascularized.

VI. Summary

Analysis of 546 reconstructive vascular operations on 521 patients shows that the prognosis as to preservation of limbs is improved by 50% as compared to the spontaneous course of occlusive arterial disease. In our view there is no place for alloplastic bypass procedures below the inguinal ligament (failure rate of 78% after 5 years). Semi-closed thromboendarterectomy on the other hand leaves 70% patent vessels after 5 years. The results after autologous vein bypass are at least equally good (96 to 100% patent vessels after 2 to 3 years).

Success in this field of vascular surgery depends on several factors: 1) a critical 3-point-program of operative indications; 2) the correct choice of operative measures. In view of the possibility of recurrent occlusions the first operation should be a simple, semi-closed thromboendarterectomy, leaving the way open for a later vein bypass if necessary; 3) an aggressive approach to all recurrent occlusions before amputation is even considered. In every one of 51 such reoperations the arterial flow was restored successfully.

References

- Blaisdell, F. W., Hall, A. D. and Thomas, A. N.: Surgical Treatment of Chronic Internal Carotid Artery Occlusion by Saline Endarterectomy. *Ann. Surg.*, 163:103, 1966.
- Boyd, A. M.: The Natural Course of Arteriosclerosis of the Lower Extremities. *Angiology*, 11:10, 1960, *Proc. Roy. Soc. Med.*, 55:591, 1962.
- Cannon, J. A. and Barker, W. E.: Successful Management of Obstructive Femoral Arteriosclerosis by Endarterectomy. *Surgery*, 38:48, 1955.
- DeBakey, M. E. and Cooley, D. A.: Surgical Considerations of Acquired Diseases of the Aorta. *Ann. Surg.*, 139:763, 1954.
- DeBakey, M. E., Crawford, E. S., Morris, G. C., Cooley, D. A. and Garret, H. E.: Late Results of Vascular Surgery in the Treatment of Arteriosclerosis. *J. Cardiovasc. Surg.*, 5:473, 1964.
- DeWeese, J. A., Barner, H. B., Mahoney, E. B. and Rob, C. G.: Venous Bypass Grafts and Thromboendarterectomies for Atherosclerotic Lesions of the Femoro-popliteal Arteries. *Ann. Surg.*, 163:205, 1966.

7. Dos Santos, J. C.: Sur la désobstruction des thromboses anciennes. *Mém. Acad. Chir.*, 73:409, 1947.
8. Dos Santos, J. C.: Late Results of Reconstructive Arterial Surgery. *J. Cardio. Surg.*, 5:445, 1964.
9. Dotter, C. T., and Judkins, M. P.: Transluminal Treatment of Arteriosclerotic Obstruction. Description of a New Technic and a Preliminary Report of Its Application. *Circulation*, 30:654, 1964.
10. Edwards, W. S.: Composite Reconstruction of the Femoral Artery with Saphenous Vein after Endarterectomy. *Surg. Gynec. Obstet.*, 110:651, 1960.
11. Edwards, W. S.: Composite Reconstruction of Small Leg Arteries after Endarterectomy. *Surgery*, 51:58, 1962.
12. Edwards, W. S., Holdefer, W. F. and Mohdashemi, M.: The Importance of Proper Caliber of Lumen in Femoro-popliteal Artery Reconstruction. *Surg. Gynec. Obstet.*, 122:37, 1966.
13. Hall, K. V.: The Great Saphenous Vein Used *in situ* as an Arterial Shunt after Vein Valve Extirpation. *Acta Chir. Scand.*, 128:245, 365, 517, 1964.
14. Heberer, G., Rau, G. and Löhr, H. H.: *Aorta und Große Arterien*. Berlin, Heidelberg, New York: Springer, 1966.
15. Hess, H., Kunlin, J., Mittel-Meier, H., Schlicht, L. and Stampfl, B.: Die obliterierenden Gefäßerkrankungen. München-Berlin: Urban u. Schwarzenberg, 1959.
16. Hierton, T. and Lindberg, K.: Cystic Adventitial Degeneration of Popliteal Artery. *Acta Chir. Scand.*, 113:72, 1957.
17. Humphries, A. M., de Wolfe, V. G., Young, J. R. and Le Fevre, F. A.: Evaluation of the Natural History and the Result of Treatment in Occlusive Arteriosclerosis Involving the Lower Extremities in 1850 Patients. In: Wesolowski, S. A. and Dennis, C.: *Fundamentals of Vascular Grafting*. New York, Toronto, London, McGraw Hill Co., p. 424, 1963.
18. Juergens, J. L., Barker, N. W. and Hines, E. A.: Arteriosclerosis Obliterans: Review of 520 Cases with Special Reference to Pathogenic and Prognostic Factors. *Circulation*, 21:188, 1960.
19. Kinmonth, J. B., Rob, C. G. and Simeone, F. A.: *Vascular Surgery*, London, E. Arnold, 1962.
20. LeVern, H. H.: Technical Features in Endarterectomy. *Surgery*, 57:22, 1965.
21. Linton, R. R. and Darling, R. C.: Autogenous Saphenous Vein Bypass Graft in Femoro-Popliteal Obliterative Arterial Disease. *Surgery*, 51:62, 1962.
22. Mentha, Ch.: Dégénérescence Kystique Adventitielle ou bursite de l'artère poplitée. *J. Chir.*, 89:173, 1965.
23. Pässler, H. W.: Zur Technik der Desobliteration ("Endarterektomie") großer Arterien (Querschnitte und Quetschverfahren), *Thoraxchirurgie*, 14:179 (1966).
24. Rau, G., Giessler, R. und Heberer, G.: Operationsindikation und Chirurgische Behandlung Chronischer Arterieller Durchblutungsstörungen. *Internist*, 6:216, 1965.
25. Sobel, S., Kaplitt, M. J., Reingold, M. and Sawyer, P. N.: Gas Endarterectomy. *Surgery*, 59:517, 1966.
- 25a. Szilagyi, D. E.: Ten Years' Experience with Aorto-iliac and Femoro-popliteal Arterial Reconstruction. *J. Cardio. Surg.*, 5:502, 1964.
26. Tiedemann, F.: *Von der Verengung und Schließung der Pulsadern in Krankheiten*. Heidelberg, Leipzig, K. Groos, 1843.
27. Vesalius, A.: On Dissection of the Living: What Might be Learned by Dissection of the Dead and What of the Living 1542. *Zit. bei Hoopes, J. E. and W. R. Webb. Arch. Surg.*, 88:421, 1964.
28. Vogt, B.: *Die Rekonstruktive Gefäßchirurgie*. Stuttgart, Thieme, 1965.
29. Vollmar, J.: Die Cystische Adventitia-Degeneration der Schlagadern.. *Z. Kreislaufforsch.* 52:1028, 1963.
30. Vollmar, J.: Ausschälplastik (Thrombendarteriekтомie) bei chronischen Arterienverschlüssen, *Actuelle Chir.*, 1:91, 1966.
31. Vollmar, F.: *Rekonstruktive Chirurgie der Arterien*. Thieme, Stuttgart, 1967.
32. Vollmar, J., Coerper, H. G. und Haubrich, B.: Chronische Verschlußprozesse der Kniekehlschlagader. Möglichkeiten und Grenzen ihrer chirurgischen Therapie. *Langenbecks Arch. Klin. Chir.*, 307:1, 1964.
33. Vollmar, J., Kratzert, R. und Meissner, H. J.: Die chirurgische Behandlung der chronischen Arterienverschlüsse im femoro-poplitealen Abschnitt. *Langenbeck Arch. Klin. Chir.*, 302:588, 1963.
34. Vollmar, J., Hild, R. and Laubach, K.: Schwere chronische Gliedmaßenischämie bei arteriellen Verschlußkrankheiten *Münch. med. Wschr.* 108:894, 1966.
35. Voorhess, A. B., Jaretzki, A. H. and Blakmore, A. H.: The Use of Tubes Constructed from Vinyon "N" Cloth in Bridging Arterial Defects. *Ann. Surg.*, 135:332, 1952.
36. Waibel, P.: Häufigkeit und Anordnung von Unterschenkelverschlüssen bei segmentärer Obliteration der Arteria femoralis superficialis. *Verh. dtsh. Ges. Kreisf.-Forsch.*, p. 424, 1963.
37. Waibel, P.: Häufigkeit und Anordnung der Lokalisation arterieller Stenosen und Verschlüsse bei organischen Durchblutungsstörungen. *Langenbeck Arch. Klin. Chir.*, 314:189, 1966.
38. Warren, R., Gomez, R. L., Marston, J. A. P. and Cox, J. S. T.: Femoro-popliteal arteriosclerosis obliterans: arteriographic patterns and rates of progression. *Surgery*, 55:135, 1964.
39. Wesolowski, S. A. and Dennis, C.: *Fundamentals of Vascular Grafting*. New York, Toronto, London, McGraw-Hill Comp., 1963.
40. Widmer, L.: Verlauf des chronischen Verschlusses von Gliedmaßenarterien: Folgerungen für die chirurgische Therapie. 5. Jahresvers. *Schweiz. Ges. Angiologie. Zürich*, 19:11, 1966.
41. Wilie E. J., Binkley, F. M. and Aldo, R. J.: Femoro-popliteal endarterectomy, Operative Modifications and Considerations of Effects of Outflow Lesions. *Amer. J. Surg.*, 108:215, 1964.