

Iliofemoral venous thrombectomy followed by percutaneous closure of the temporary arteriovenous fistula

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Iliofemoral venous thrombosis treated by anticoagulants alone almost invariably results in postthrombotic sequelae with deep venous reflux alone or combined with an outflow obstruction. This study evaluates the result of iliofemoral venous thrombectomy with temporary proximal arteriovenous fistula (AVF) performed on 48 consecutive patients. In 10 patients the thrombus extended in the inferior vena cava, and the thrombectomy was combined with inferior vena cava interruption. The AVF closed spontaneously in 8 of 48 patients (patency rate, 84%). An attempt to close the AVF by placing a detachable balloon percutaneously under radiographic control was made 6 to 12 weeks later (success rate, 87%; complications, rare). A preclosure arteriovenography of the femoro-iliaco-caval segment revealed 34 of 35 segments open (patency rate, 89%). Four patients had severe stenosis of the iliac segment, and a transvenous percutaneous dilatation was successfully performed in three of the four patients, keeping the fistula. At AVF closure 4 weeks later the arteriovenography showed sustained dilatation in only two patients. Thirty-seven patients were followed for 3 to 48 months (median, 24 months) and 30 of 37 patients (81%) who had no symptoms were not using compression stockings. Doppler investigation revealed patent and competent femoral and popliteal veins and normal photoplethysmography in 56% of the patients. Four iliac veins were occluded (patency rate, 88%). No recurrence of fistula had occurred. Venous iliofemoral thrombectomy seems to better preserve valve function. The percutaneous balloon closure of the AVF has decreased the complication rate, facilitated venographic evaluation of the result, and made possible the performance of percutaneous interventions under the protection of the AVF. (SURGERY 1991;110:493-9.)

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DEEP VENOUS THROMBOSIS (DVT) involving the iliofemoral segment is a more serious condition than when it is limited to the calf alone. If untreated, pulmonary embolism is reported to occur in one half of the cases with 30% deaths.¹ Even during anticoagulation treatment 21% of patients will develop pulmonary emboli.² The conservatively treated high DVT is often followed by disabling postthrombotic sequelae of considerable socioeconomic importance, especially in a young, active

population.^{3,4} The incidence of leg ulcers after nonsurgical treatment has been reported as high as 75% after 5 years.¹ Although recanalization by endogenous fibrinolysis might result in regained patency, the valves almost invariably are ruined in the inflammatory process, and severe reflux occurs. An increasing number of reports indicate that thrombectomy with a temporary arteriovenous fistula (AVF) is decreasing the risk of fatal embolism and the later development of postthrombotic syndrome by preserving the valve function.⁵⁻⁹ One of the major obstacles for acceptance of the operative treatment has been the need to surgically dismantle the temporary AVF with associated complications. In addition, early objectivity in showing the patency of the veins has been difficult, except when subjecting patients who have no symptoms to ascending venography.

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Table I. Causes of iliofemoral DVT in 48 patients

Delivery/pregnancy	11
Gynecological operations	3
Trauma	6
Postoperative	7
Nephrotic syndrome	1
Retroperitoneal fibrosis	1
Miscellaneous	5
Unknown	14

This prospective study describes the good results of thrombectomy with temporary AVF and evaluates the improvement after the introduction of a percutaneous method to visualize the iliofemoral segment, to occlude the fistula by a detachable balloon, and if necessary to perform percutaneous intervention under the protection of the AVF.

MATERIAL AND METHOD

From 1982 to 1989 more than 300 patients with iliofemoral vein thrombosis have been managed in our unit. Operative intervention was considered warranted in 122 cases. In 90 patients a venous thrombectomy combined with an AVF was performed. The operative technique is described elsewhere.¹⁰ After the removal of the thrombus an AVF was fashioned with the proximal long saphenous vein that was anastomosed end-to-side to the superficial femoral artery. In the early period the AVF was encircled by a Mersilene mesh or polytetrafluorethylene patch to facilitate its identification at the surgical closure 6 to 8 weeks later. The fistula was ligated and divided while the patient was under local anesthetic. In 1986 a new method to obliterate the AVF was introduced.¹¹ A detachable balloon was placed in the fistula percutaneously under direct radiographic control. In the first 10 cases the femoral artery approach was from the operated groin, but because of difficulty caused by scar tissue and with continuous refinement of the balloon catheters the contralateral groin was later used for puncture. Before the inflation and detachment of the balloon an arteriovenography was performed to evaluate the patency of the iliofemoral and caval veins. After release of the balloon a repeated angiography could document the complete obliteration of the fistula. Because no surgical dismantling was necessary, the identifying mesh previously applied for identification was no longer needed, and the fashioning of the fistula was facilitated with no foreign material.

This study is comprised of 48 consecutive patients (mean age, 37 ± 13 years [SD; range, 17 to 64 years]; female, 26; male, 22; left leg DVT, 38; right leg DVT,

11) operated after the introduction of the percutaneous balloon closure. Four patients had a history of contralateral calf vein thrombosis, and one patient had a history of an ipsilateral calf vein thrombosis. The probable cause of the iliofemoral DVT is outlined in Table I. In nearly one half of the women the thrombosis was associated with pregnancy or delivery. Hematologic abnormality regarding protein S and C, factor VIII antigen, antithrombin III, and/or decreased fibrinolytic activity was found in nine patients; four patients belonged to the idiopathic group. After 25 months DVT developed in the other leg of the patient with the nephrotic syndrome; the patient underwent successful bilateral operation.

The median duration of symptoms before admission was 3 days (range, 1 to 14 days). Only five patients had a history longer than 7 days. All patients were admitted with complaints of lower limb swelling and pain. In addition, eight patients had symptoms of pulmonary embolism. Diagnosis was established with an ascending venography of the symptomatic leg followed by a transfemoral venography through the contralateral side to delineate the extent of thrombosis in the iliac vein and the inferior vena cava (IVC). Whole lower limb thrombosis was detected in 37 legs, although 12 of the legs had isolated iliofemoral thrombosis. Extension in the IVC was found in 10 patients of whom only four patients had a free calf segment. Radioisotope perfusion/ventilation scans before and after operation were performed in 43 patients.

All patients underwent the operation described. The patients with involvement of the IVC had thrombectomy of the cava after interruption below the renal vein. In one patient, leg fasciotomy was required to relieve a severe compartment syndrome. An attempt to close the fistula with a balloon was made 6 to 12 weeks later. If preclosure angiogram through the fistula showed a significant iliac stenosis (>75%), an immediate dilatation was performed through direct puncture of the vein. The AVF was kept to protect the intervention for another 4 weeks, when the procedure was repeated.

At follow-up the patient was evaluated by history, physical examination, venous Doppler ultrasonographic investigation for patency and competence of the femoral and popliteal veins bilaterally, and determination of the refilling time with photoplethysmography. Chi square was utilized to determine statistical significance ($p < 0.05$).

RESULTS

In addition to preoperative pain and swelling of the involved leg, 8 of the 48 (16%) patients described symp-



Fig. 1. Preclosure arteriovenography reveals a significant stenosis of the common iliac vein (A). Inflated angioplasty balloon with a "waste" formation at the stenotic site (B).

toms of pulmonary embolism. All of these patients had positive findings on pulmonary scans. Another 15 patients had no symptoms, but scans revealed pulmonary embolism, giving an overall positive scan rate of 53% (23 of 43 patients). Stratifying the material in patients with IVC involvement versus pure iliofemoral DVTs resulted in a symptomatic and pulmonary scan-positive pulmonary embolism frequency of 40% and 60% ($n = 10$) versus 12% and 48% ($n = 33$), respectively. Comparing left iliofemoral versus right iliofemoral DVTs, the frequency was 8% and 42% ($n = 24$) versus 22% and 67% ($n = 9$), respectively. Thus the extension of an iliofemoral DVT in the IVC and its location to the right side had a higher frequency of both symptomatic and scan-positive pulmonary emboli.

The removed thrombus was considered subjectively by the surgeons to be reddish fresh in 13 cases, of mixed composition in 34 cases, and whitish old in 2 cases. The operations of two patients were considered as primary surgical failures despite a patent iliac segment because the calf and thigh veins rethrombosed on the day 3 after the operation. One of the patients had a history of ipsilateral calf vein thrombosis. The second patient had a postdelivery thrombosis with severe iliac vein stenosis. One patient died on day 32 after the operation of a multiorgan failure after a severe hemorrhage caused by excessive anticoagulation. He was 64-years-old and at admission had chronic obstructive airway disease and

preoperatively unknown liver cirrhosis with symptomatic pulmonary embolism.

In the first 3 days the AVF closed spontaneously in 8 of the 48 patients (patency rate, 84%). Two patients with patent fistula left the country despite being advised to have the fistula closed. Attempts to obliterate the fistula by detachable balloon were successful in 33 of the remaining 38 limbs (87%). The fistulas of the other patients were closed by operation or insertion of coils. The failures and complications to the procedure occurred among the first 10 cases and were secondary to kinked introducer (tough scar), anastomotic stenosis (two cases), short AVF (less than 3 cm), and one severely kinked fistula. The complication rate was minimal. No infection occurred, but hematoma developed in two cases, resulting in rethrombosis of the iliac vein in one case. The AVF was closed after 4 to 36 weeks (median, 8 weeks). No recurrence of the AVF was observed during the follow-up period.

In eight patients the mean fistula flow was measured with a dye dilution technique at the obliteration procedure. The average fistula flow was 1.4 ± 0.2 L/min (SEM; $n = 8$; range, 0.3 to 4.7 L/min). Even the patient with the high fistula flow had no symptoms. At the preclosure angiogram one patient had occlusion of both the iliac and femoral veins; only the iliac was obliterated in three patients. The iliofemoral segment was found patent in 34 of the 38 limbs (89%). A mild, hemody-

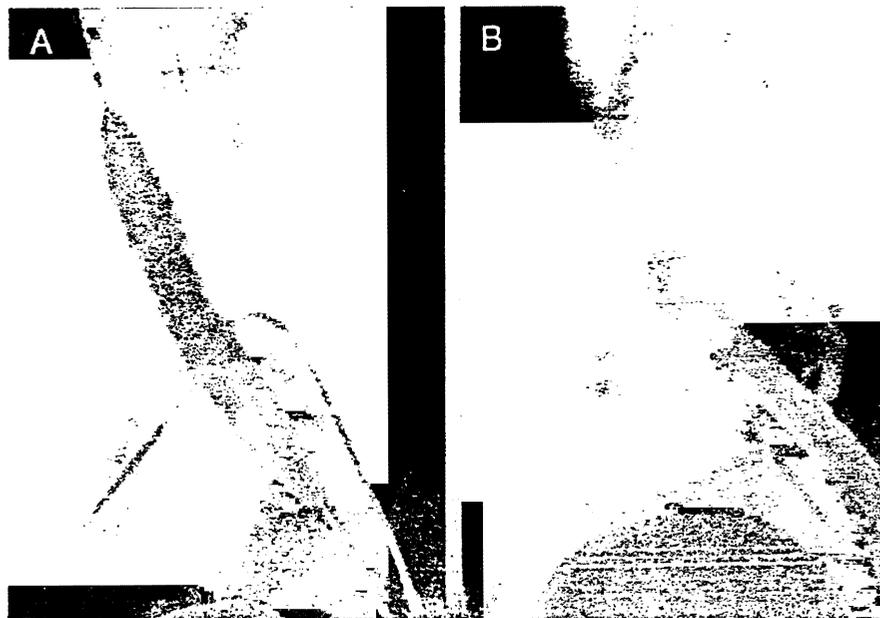


Fig. 2. The angioplasty balloon fully inflated (A). Completion arteriovenography shows normal common iliac vein (B).

Table II. Investigation at follow-up of 37 patients after iliofemoral venous thrombectomy compares affected and nonaffected lower limb

	Affected limb	Nonaffected limb
Thigh circumference (cm)	54.7 ± 6.0	53.7 ± 6.0
Calf circumference (cm)	36.3 ± 3.8	35.7 ± 3.9
Refilling time (PPG, s)	22.3 ± 8.5	29.6 ± 7.4
Ankle/arm pressure (mm Hg)	1.1 ± 0.1	1.1 ± 0.1

All data are mean ± SD.

namically insignificant stenosis was seen in five patients. Another four patients had severe stenosis, and a transvenous percutaneous dilatation was performed (Figs. 1 to 3). The immediate result was excellent in three cases with short stenosis (<3 cm), decreasing the pressure gradient from 13 to 26 mm Hg to 3 to 9 mm Hg and increasing the lumen diameter at least 100%. The fourth patient had DVT after severe pelvic injury with organized hematoma surrounding two stenoses involving 7 cm of the vein. The pressure gradient only improved from 33 to 44 mm Hg to 16 to 17 mm Hg, and the lumen diameter increase was limited to 50%. The AVF was kept for another 4 weeks after which it was obliterated. A renewed angiovenogram at that time showed sustained dilatation in two patients, partial improve-

Table III. Results of venous Doppler investigation of 34 limbs after iliofemoral venous thrombectomy

	Competent (%)	Patent (%)
Iliofemoral vein segment	26 (76)	30 (88)
Popliteal vein segment	22 (65)	32 (94)
Both segments	19 (56)	30 (88)

ment in one patient, and complete recurrence of the stenosis in one patient after trauma.

Eleven (22%) of the 48 patients were lost to follow-up. Excluding the postoperative death, eight patients had either left the country or refused to submit to investigations. The AVFs of two patients had not been closed. The median follow-up time was 24 months (range, 3 to 48 months). Only seven (19%) of 37 patients were using compression stockings, and 30 (81%) of the patients were completely without symptoms. Leg swelling was found in seven (19%) of 37 patients, although three patients were unaware of it. No significant difference was found comparing the average thigh and leg circumference of the previously affected limbs to the nonaffected lower limbs (Table II). One patient with bilateral var-

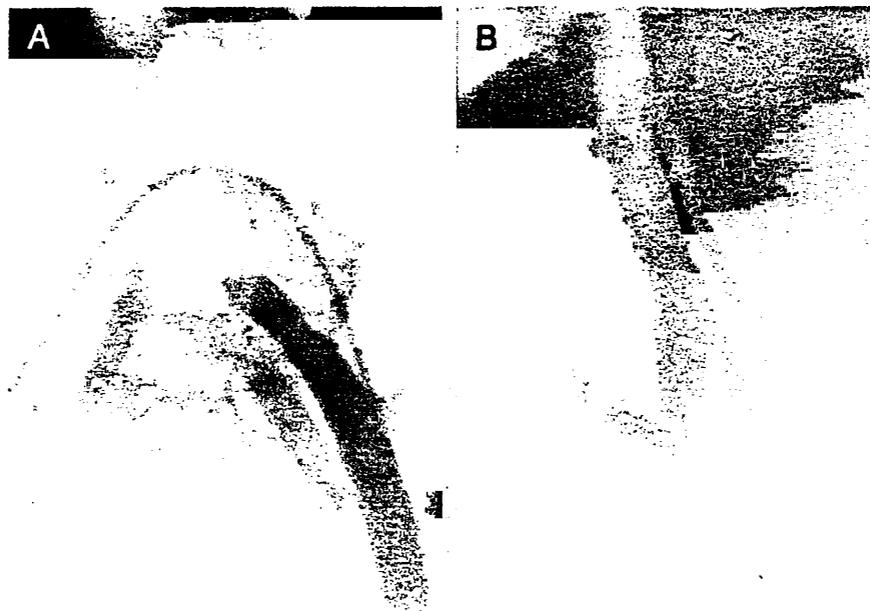


Fig. 3. Repeated preclosure arteriovenography 4 weeks later shows a recurrence of the venous stenosis (A). Final angiography shows the balloon completely obliterating the AVF and normal arterial morphology.

icose veins before operation was still complaining of pain on prolonged standing. He had an iliac vein occlusion that was detected by the preclosure angiogram. No case of secondary varicose veins, hyperpigmentation, or leg ulcer was reported.

The results of the noninvasive vascular investigations are given in Tables II and III. The Doppler investigation revealed both iliofemoral and popliteal segments patent and competent in 19 (56%) of the 34 cases; patency combined with competence of one of these two valve segments was found in 30 (88%) of the 34 cases. All of the patients with normal findings, except one with incompetent calf perforators, had normal photoplethysmography. The Doppler investigation of the nonaffected leg was essentially normal. Although the average refilling time of the affected leg is lower compared to the nonaffected leg, the refilling time is still above normal. Photoplethysmography was normal (>20 seconds) in 23 (62%) of the 37 affected limbs and in all of the nonaffected limbs. The long and short saphenous veins were patent and competent in 91% (31 of 34 cases) and 88% (30 of 34 cases), respectively. Average ankle and arm pressure of both legs was the same, although two patients had significant stenosis of the superficial femoral artery on the angiogram. One patient never developed any symptoms. The other patient, who complained of disabling intermittent claudication, refused dilatation and developed complete occlusion. At follow-

up 2 years later she had no symptoms and normal distal pulses. The lowest pressure ratio at any time was 0.7.

In this material no difference was noted in the outcome between operations performed for a DVT limited to the iliofemoral segment or a thrombosis including both thigh and calf, whether the AVF was patent or not. Probably the number of patients is inadequate to allow conclusive analysis.

The present group of patients was compared to 39 consecutive similar patients operated before the introduction of percutaneous balloon closure. No difference was noted in the length of hospital stay (median, 16 days [range, 7 to 79 days] versus 16 days [range, 8 to 77 days]). However, there was a significantly lower rate of wound ooze of serous fluid (5% [2 of 38 patients] versus 21% [8 of 39 patients]) and wound infection (5% [2 of 38 patients] versus 21% [8 of 39 patients]) in the balloon obliteration group (with no foreign material around the AVF) compared to the operative closure group (with a mesh at the primary operation). In addition, the AVF patency rate was higher (84% versus 68%).

DISCUSSION

Anticoagulation treatment of iliofemoral DVT has efficiently prevented pulmonary embolism and given immediate symptomatic relief. The subsequent unavoidable recanalization is often incomplete and always results in destruction of valves. Only 30% of iliac vein

segments remain open, and almost invariably a severe reflux will be found 5 years later.¹² The venous hypertension leads to postthrombotic sequelae in 66% to 82% of patients.^{12, 13} Its severe state with venous claudication or venous ulcers will develop in one of three cases with time.^{1, 12, 14} Thus the conservative treatment of iliofemoral venous thrombosis with anticoagulation alone is not an optimal method.

The present results after thrombectomy with AVF show that approximately 2 years after surgery more than 80% of patients have no symptoms with patent iliofemoral vein segments and at least one valve competent in the popliteal-femoral region. The patients with afflicted limbs compared favorably with the patients with no symptoms. A review of average published results shows that 63% of patients have no symptoms, an iliac patency rate of 71%, and an iliofemoral competency rate of 45% after a follow-up time of 6 to 60 months.¹⁰

Published late results after thrombectomy are few. Forty-six patients were followed for 5 to 13 years (average, 10 years) after thrombectomy without AVF and an immediate iliac patency rate of 63%. Forty percent had symptoms, although one of three patients had severe venous insufficiency with swelling/ulcer. Little difference was noted between the follow-up at 5 months compared to 10 years.¹⁵ If the early follow-up with venography after operation shows a radical thrombectomy, these patients seem to retain their good venous function in the future. A similar conclusion was made by Ganger et al,⁷ who followed a surgically treated group and a matched medically treated group after 8 years. They found clinical and hemodynamic results after surgery superior to conservative management, especially when the thrombosis was less than 3 days old. Material from only one prospective, randomized study that was attempting to evaluate surgery versus anticoagulation alone has been published.^{5, 9} At 6 months 42% versus 7% of treated patients were found to have absolutely no symptoms, with 76% versus 35% iliac vein patency rate and competent and patent femoro-popliteal veins in 52% versus 26%. After 5 years the figures were 37% versus 18%, 71% versus 30%, and 36% versus 11%, respectively. However, at this time the average age of patients was high and more than one third of patients were lost for follow-up at 5 years, making statistical analysis unreliable and definite conclusions impossible. Despite this fact we believe that thrombectomy for iliofemoral vein thrombosis has proved itself superior to anticoagulation treatment, preventing outflow obstruction and deep venous reflux to a higher degree and thus substantially decreasing the postthrombotic sequelae.

The discrepancy between the rate of symptomatic pulmonary emboli of 16% and the three times higher finding of scan-positive perioperative pulmonary emboli has been well described. The thrombectomy does not cause significant perioperative embolism and does not seem to be superior to anticoagulant treatment in preventing later pulmonary embolism, which rarely is symptomatic or fatal.^{2, 7}

The balloon thrombectomy will always result in an endothelial injury with risk of secondary thrombosis. One of the objectives of creating an AVF is to decrease postoperative rethrombosis by increasing the flow. Hutschenreiter et al.¹⁶ found that the AVF increased the iliac patency rate from 54% to 83%. The minimal flow needed to keep the fistula patent is not known, but it should be at least 100 ml/min if technical errors are excluded.¹⁷ The fistula flows in this study were well above this level. Although at times very high flow was present, no patient developed cardiac insufficiency.

The major disadvantage of the creation of a temporary AVF has been the necessity to close it surgically. Different methods have been developed to avoid or facilitate this (e.g., external, "button-loop," silk ties around fistula, mesh wrapping, steel wires). The second operation in the scarred area of previous surgery carries a significant additional risk of wound infection and arterial and venous injury.¹⁸ In this study the practice of subcutaneous loop with mesh wrapping had a high rate of wound infection and lymphatic ooze at the first operation. This was significantly decreased by the introduction of the percutaneous balloon closure technique. The failed attempts with percutaneous balloon closure occurred early in the series during the development of the technique. After introduction of the contralateral groin approach, failures have been extremely rare.

Before closing the temporary AVF, delineating the venous outflow either through an ascending venogram or arteriovenogram was vital. Many patients who have no symptoms will not allow this investigation, although it will show the result of the operation and be of prognostic importance. More than 10% of patients have a remaining significant iliac vein stenosis, despite successful initial surgery. At the second operation when the AVF is dismantled, these stenoses can be dilated.⁸ The present technique combines diagnostics and therapy. The angiovenogram may immediately be followed by a percutaneous vein dilatation. The temporary AVF will remain and prevent rethrombosis after the intervention. Before its later obliteration the result of the dilatation can again be depicted by a repeat angiovenogram before the closure of the AVF.

The limited experience of venous dilatation in this study was not encouraging. There is, no doubt, a major difference between the vein and artery-wall response to dilatation. The present results indicate an early recurrence of the stenosis. This might be due to surrounding pressure or to the healing process itself with fibrosis. The outcome of dilatation would possibly be improved by the insertion of an endoluminal expandable stent reinforcing the dilated vein.¹⁹ With the present method these interventions may be performed percutaneously, and the dilatation with stent placement may be protected by the temporary fistula. These techniques need further evaluation but might prove to be an important complement to improve the outcome after iliofemoral thrombectomy.

The iliofemoral thrombectomy with temporary AVF is not of major importance in preventing postoperative pulmonary embolism. The important objective of the operation is to preserve valves. Compared to anticoagulation treatment, thrombectomy with AVF is superior, preventing outflow obstruction and deep venous reflux to a higher degree and thus substantially decreasing severe postthrombotic sequelae. The change of surgical technique caused by the availability of percutaneous balloon closure has facilitated the primary operation with fewer complications and a higher AVF patency rate. The surgical dismantling of the AVF is largely unnecessary. In addition, the percutaneous technique has made the assessment of the immediate postoperative result uncomplicated, and it is possible to perform percutaneous interventions under the protection of the AVF.

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