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ORIGINAL ARTICLE

Combined Percutaneous Endovascular Iliac Angioplasty and Infrainguinal Surgical Revascularization for Chronic Lower Extremity Ischemia: Preliminary Result

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The purpose of this study was to evaluate the efficacy of combined ipsilateral percutaneous iliac angioplasty and open infrainguinal surgical techniques for the treatment of patients with multilevel arterial occlusive disease. Combining two types of approaches in the peripheral vascular field is a less aggressive technique and may result in excellent early patency and limb salvage rates. We report our initial experience with a combined percutaneous endovascular iliac angioplasty and infrainguinal surgical reconstruction for patients with chronic lower extremity ischemia associated with multilevel arterial occlusive disease who presented with severe (disabling) lower limb claudication that significantly reduced quality of life, as well as patients with rest pain, nonhealing ulcers, and gangrene.

There were 30 patients, 20 of whom had percutaneous transluminal angioplasty (PTA) only and 10 who had PTA with a stent. The infrainguinal procedures associated with each were thromboendarterectomy with vein patch angioplasty of both the common femoral artery (CFA) (12 patients), and the popliteal artery (8 patients) and a short femoropopliteal bypass for the superficial femoral artery (SFA) after recanalization of the arterial lumen using thromboendarterectomy to shorten the bypass graft (10 patients), using a reversed saphenous vein graft. The procedures were performed from July 2007 to February 2008 at the Division of Vascular and Endovascular Surgery, Al-Hussein University Hospital (Al-Azhar Faculty of Medicine, Cairo, Egypt).

The study included 30 patients, 17 males and 13 females, with a mean age of 54 years (range 42–72) who underwent both combined ipsilateral percutaneous endovascular iliac angioplasty and open surgical treatment of both femoral (ie, the CFA or the SFA) and popliteal occlusive diseases. Indications were claudication that reduced quality of life after failure of conservative medical treatment in 14 patients (46.6%), critical limb ischemia in 8 patients (26.7%), and tissue loss, nonhealing ulcers, and gangrene in 8 patients (26.7%). Initial technical and hemodynamic success was achieved in 100% of cases. Clinical success was achieved in 96.7% of cases after 6 months, and clinical failure was observed in 3.3% of cases owing to occlusion of the short femoropopliteal bypass graft. Good hemodynamic results were observed in 74.9% of cases as the mean postoperative ankle-brachial index remained elevated to 1.03 ± 0.1 and 1.07 ± 0.12 after 3 and 6 months, respectively.

Combined vascular therapy may be used effectively in patients with chronic extremity ischemia owing to multiple levels of arterial occlusion and should be performed with good results. Technical success and early patency rates are excellent. The patients' symptoms improved and resistant ischemic ulcers healed within a short period of time.

Key words: *balloon angioplasty and stenting, chronic lower extremity ischemia, combined percutaneous endovascular and surgical procedures, infrainguinal surgical reconstruction, preliminary results, reversed saphenous vein graft, short femoropopliteal bypass*

Endovascular procedures can be coupled with open interventions, the so-called combined procedures, which may be performed simultaneously or staged. Multilevel atherosclerotic arterial occlusive disease has been reported to be the most common pattern of occlusive disease. Correction of inflow and outflow lesions is often necessary to achieve healing of ischemic ulceration. The common occurrence of multilevel disease has increased the need for combined procedures in the form of proximal endovascular intervention and distal open surgical reconstruction for infrainguinal lesions.

Patients and Methods

Thirty patients presented with lifestyle-limiting claudication, chronic limb ischemia (CLI), and tissue compromise

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and were included in the study. They underwent combined percutaneous iliac balloon angioplasty and stenting and infrainguinal surgical reconstruction between July 2007 and February 2008. There were 17 males and 13 females, with a mean age of 54 years (range 42–72 years). Risk assessment revealed the presence of the following risk factors: smoking ($n = 9$), hypertension ($n = 3$), diabetes mellitus ($n = 13$), coronary artery disease ($n = 2$), hyperlipidemia ($n = 1$), and cerebrovascular disease ($n = 2$).

Preoperative Evaluation

All patients underwent duplex ultrasonography ($n = 30$), digital subtraction angiography ($n = 20$), computed tomographic angiography (CTA) ($n = 5$), and/or magnetic resonance angiography (MRA) ($n = 5$).

Techniques

The combined procedures were done either in the same setting (ie, percutaneous iliac angioplasty followed immediately by endarterectomy with vein patch angioplasty) or as a staged procedure (ie, percutaneous endovascular iliac angioplasty first followed by infrainguinal surgical revascularization within 2 to 4 days). The endovascular procedures were done in the angiography suite of the endovascular surgery division.

Endovascular Procedures

Endovascular balloon angioplasty and stent techniques were done prior to surgery in all cases to correct the inflow obstruction (ie, stenoses or occlusion) of the common iliac artery or external iliac artery of the affected limb (Table 1 and Figure 1).

The balloon is initially deformed by the adjacent plaque and assumes a tubular configuration in most successful angioplasties. Once the balloon has become tubular, the angioplasty has been completed; then the balloon is completely deflated and withdrawn several centimeters from the angioplasty site. A completion angiography is done if a significant stenosis remains, or if there is a significant dissection, a self-expanding stent is deployed (Figure 2).

Table 1. Types of Percutaneous Iliac Angioplasty Procedures

Operative Procedure	*Balloon and Stent Used*	n– *(%)*
Balloon angioplasty	High-pressure balloon	20 (66.6)
Balloon angioplasty and stent	Self-expanding stent	10 (33.4)

Figure 1. Left common iliac artery occlusion.

Open Surgical Procedures

Open surgical infrainguinal reconstructions are always performed after correction of arterial inflow by percutaneous endovascular technique. Surgical procedures include thromboendarterectomy with vein patch angioplasty of the common femoral artery (CFA) (40%) and the popliteal artery (26.7%) and thromboendarterectomy with above-the-knee short femoropopliteal bypass using a reversed saphenous vein graft (33.3%) (Figure 3-8).

Follow-Up

Following the procedure, we tested the patency of the endovascular and the bypass graft procedures by regular follow-up every 2 weeks in the first 3 months and then every month for the next 6 months for interval history (new symptoms), vascular examination of the limbs with palpation of the peripheral pulses, Doppler ultrasonography with measurement of the ankle-brachial index (ABI), and/or duplex ultrasonography and CTA and occasionally MRA. The outcome parameters included primary patency, limb salvage, and survival. The criteria of success after treatment consisted of a combination of clinical and hemodynamic improvement.

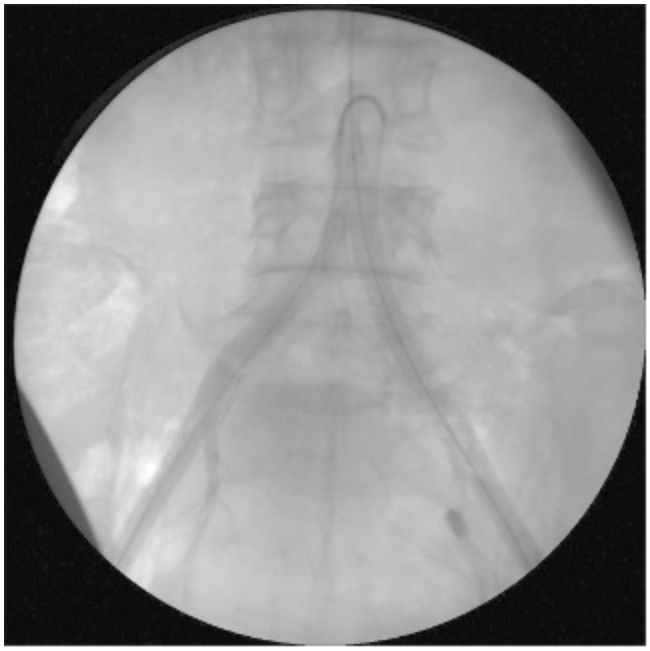

Figure 2. Left common iliac artery post-stenting.

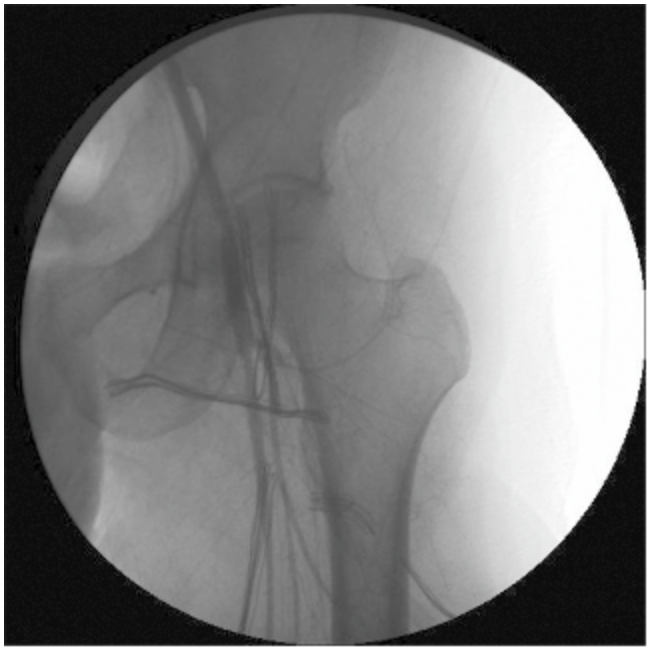

Figure 4. Patent left CFA after thromboendarterectomy and repair using vein patch angioplasty.

Patency

Patency can be defined as maintenance of achieved hemodynamic improvement in the relevant segment. Primary patency was defined as maintenance of symptomatic and hemodynamic improvement without further intervention, and the criteria for patency required the presence of a palpable pulse distal to the treated segment. Limb status was also assessed using the suggested standards for reports that deal with lower extremity ischaemia published by Rutherford.[1] Primary patency was assessed on an intention-to-treat basis. Any intervention made in the ipsilateral limb after the initial procedure was considered a revision of the entire procedure.

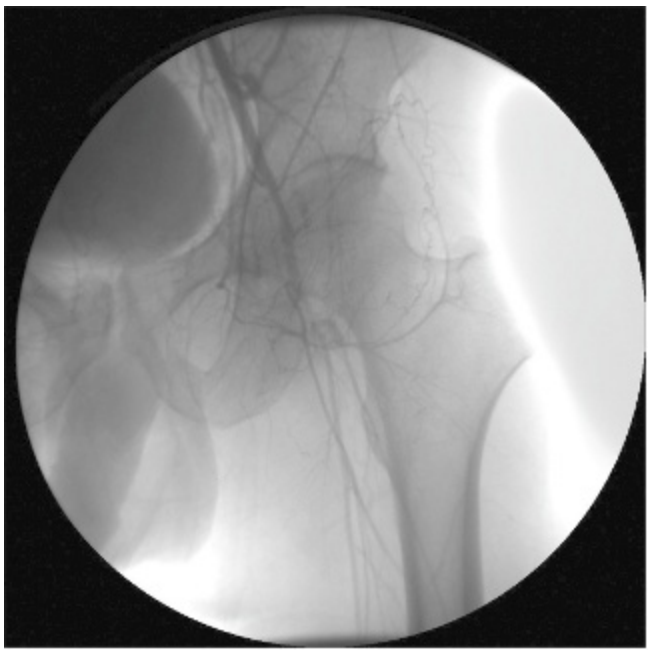

Figure 3. Left CFA occlusion.

Hemodynamic Improvement

Maintenance of an improved ABI compared to measurements before the procedures was required to be defined as

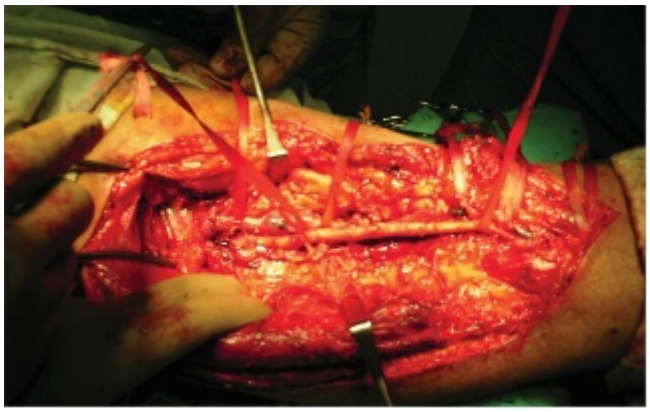

Figure 5. The popliteal artery after closure using vein patch angioplasty, posterior approach.

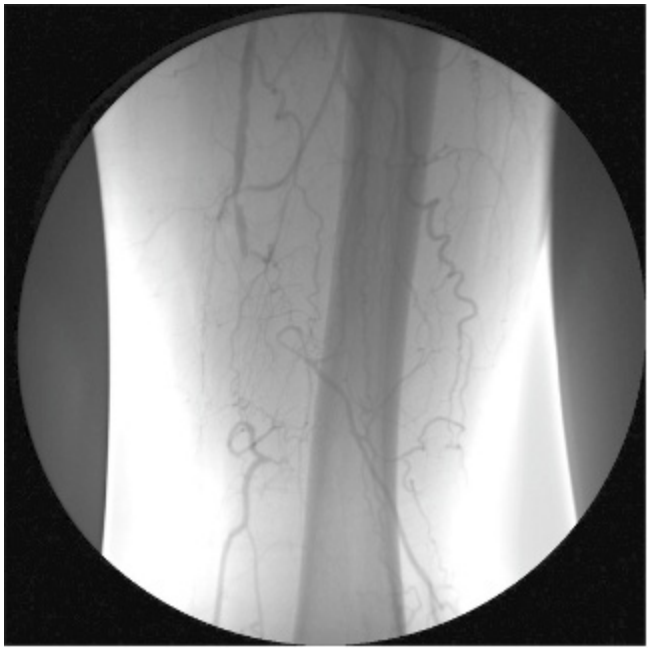

Figure 6. Left SFA occlusion.

a criterion for patency. An intervention was considered hemodynamically successful if there was a sustained rise in the postintervention ABI $>$ 0.1 above the baseline value or an increase in the ABI to 0.9.

Figure 7. The same patient with above-knee popliteal artery occlusion.

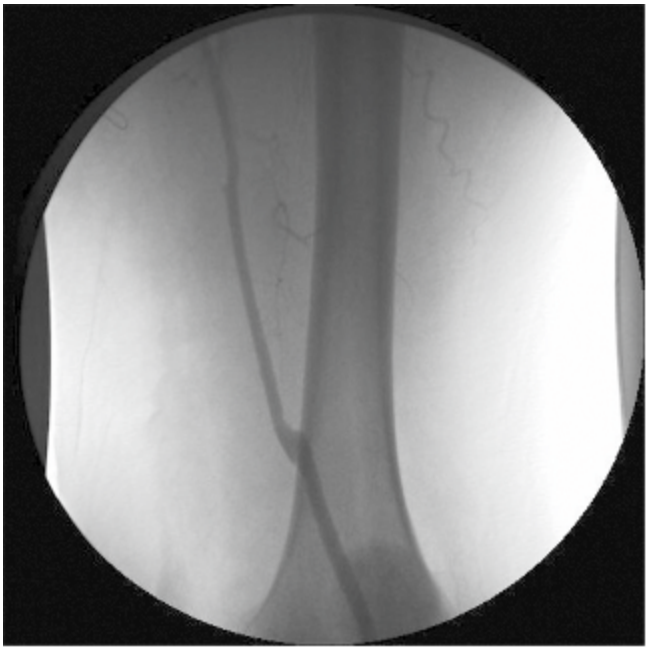

Figure 8. Completion angiography showing proximal thromboendarterectomy of the SFA, followed by above-knee short femoropopliteal bypass using reversed saphenous vein graft.

Statistical Analysis

All patients' data were collected using *SPSS* version 9.5 (SPSS Inc, Chicago, IL), and the chi-square test and paired-samples *t*-test were used to evaluate clinical and hemodynamic improvement by comparing the mean ABI before and after the procedures. A p value $<$ .05 was considered significant.

Results

All patients were classified according to Fontaine and Rutherford's classifications of clinical ischemia.[2]

Technical and Clinical Results.

Initial technical success was achieved in 100% of cases.

Clinical success was evaluated according to the pulse status of the patient and Fontain and Rutherfords classifications of clinical ischemic categories. Symptomatic improvement requires a palpable pulse distal to the treated segment and an upward shift of at least one clinical category on the scale. Clinical and symptomatic results 6 months after intervention showed that 29 patients (96.7%) were asymptomatic and 1 patient (3.3%) complained of moderate claudication. The nonhealing ulcers healed within 6 months of follow-up, and minor amputations were done for cases with gangrene of the toes.

Hemodynamic Results

The mean ABI before intervention was 0.63, and at the time of follow-up, the mean ABI remained elevated at 1.03, and 1.07 after 3 and 6 months, respectively. The mean ABIs were compared before and after the procedures by using a paired-samples *t*-test and showed statistically significant differences between the ABIs before and after the procedures, p value $< .05$. Hemodynamically, the primary patency rates for patients with chronic lower extremity ischemia who underwent percutaneous iliac balloon angioplasty and stenting in combination with open surgical procedures at 3 and 6 months were 75.1% and 74.9%, respectively.

Bypass occlusion occurred in one case 6 months after the intervention owing to occlusion of the graft, as evidenced by CTA. From the previous results, it is clear that at the latest period of follow-up (ie, 6 months), symptomatic and clinical improvement were maintained after combining the two procedures without further intervention in 96.7% of cases. Hemodynamic improvement was maintained in 74.9% of cases.

Discussion

In multilevel arterial diseases, combined endovascular and surgical techniques can be used as an alternative to laparotomy to correct the inflow lesions. Simultaneous procedures treating multilevel atherosclerotic disease are functional, especially in difficult situations such as multiple stenoses, a short lesion separated from a long lesion by a normal segment. In the last decade, vascular surgeons have become increasingly interested in and experienced with performance of percutaneous transluminal angioplasty and stenting procedures. The largest published series to date of concomitant procedures, the report by Madera and colleagues on angioplasty in the operating room, included 108 combined open and endovascular procedures among 239 endovascular procedures performed by vascular surgeons on 200 patients, and the immediate technical success rate of the angioplasty procedures was 90%.[3] But in our series, the immediate technical success was 100% compared to previous reports, in the literatures.

In our series, patients were subjected to combined proximal iliac angioplasty and distal outflow correction using short bypass grafts, which have at least patency rates to longer ones. Furthermore, they require a shorter single-vein graft segment, which is anatomically available (eg, saphenous vein). The patency rates and technical success are similar to those in other reports. There were a large number of diabetic patients (13 cases; 43.3%), and there were no significant differences in outcome between diabetics and nondiabetics, which correlates well with the report by Faries and colleagues.[4]

Combined-modality intervention has been well described. Brewster and colleagues reported good long-term results with combined iliac angioplasty and distal arterial reconstruction.[5] In our study, percutaneous iliac angioplasty was performed in 20 cases (66.6%) and stents were applied only in 10 (33.4%) of them. Twelve cases (40%) were treated with thromboendarterectomy of the CFA followed by vein patch angioplasty, 8 cases (26.7%) were treated with thromboendarterectomy with vein patch angioplasty of the popliteal artery through a posterior approach, and 10 cases (33.3%) were treated with thromboendarterectomy of the proximal part of the superficial femoral artery (SFA) followed by a short above-the-knee femoropopliteal bypass of the distal part of the SFA to the popliteal artery.

In our series, we had a superior result with good iliac artery inflow compared to the results of Lamerton and colleagues and Plecha and Plecha, in which progressive donor iliac artery inflow disease required either PTA or surgical reconstruction.[6,7] The infrainguinal bypass completes a fundamental role for lower extremity revascularization, especially to prevent limb amputation in diabetic patients with CLI. Although a proximal angioplasty is not generally enough in diabetic patients with CLI, the combination of a bypass procedure ensures a better distal perfusion. It shortens the vein segment to be used, diminishing the quantity of incisions. Being able to use a short segment of vein favors these patients with a high incidence of contralateral occlusive disease (25% requires revascularization of the other limb in the first 5 years), coronary disease, or the necessity of a graft for dialysis. Finally, surgical bypass grafting procedure at the time of endovascular treatment is acceptable and may prove to be a cost-effective approach.

Conclusion

Successful iliac artery angioplasty improves the inflow and augments collateral blood flow, thus leading to more durable results even when other segments are affected in the same leg. Furthermore, iliac artery endovascular therapy serves as an excellent adjunctive procedure for preserving inflow to surgical bypass grafts in patients with coexistent infrainguinal disease. Inflow iliac artery balloon angioplasty may be performed simultaneously or staged with open infrainguinal vascular reconstruction in patients with multilevel occlusive diseases of the lower extremity. The

advantages to patients include one combined procedure to treat lower extremity ischemia. This approach is safe and effective, has satisfactory early results, and should be part of the armamentarium of vascular surgeons.

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