

## Hybrid procedures in the treatment of obliterative arteriopathy of the lower limbs

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### Abstract

Lower extremity artery disease is defined as a narrowing of the caliber of arteries to the lower limbs, resulting in hemodynamic loss, with or without clinical symptoms, The detection and the diagnosis of peripheral arterial disease is obtained by calculating the ankle brachial index , An adapted treatment reduces the morbi-mortality linked to this disease, the management of LEAD involves controlling risk factors and hygienic-dietary measures, medical management, and finally surgical treatment (conventional surgery, endovascular treatment, or hybrid procedures).

The progress in hybrid procedures has expanded the possibilities for revascularization in patients with severe and complex arterial lesions. These techniques provide an excellent alternative for specific indications,

**Keywords:** Lower extremity artery disease (LEAD); Chronic critical ischemia of lower limb (CCLI); Hybrid procedures; Treatment

### 1. Introduction

LEAD is defined as "a narrowing of the caliber of arteries to the lower limbs, resulting in hemodynamic loss, with or without clinical symptoms, of which the best indicator is the decrease in ABI [2]. Atheromatous origin is the most common, and other etiologies may include inflammatory and genetic diseases. Several factors are involved in the occurrence of LEAD: chronic smoking, diabetes, hypertension, dyslipidemia, age, male sex, and hyperhomocysteinemia [3].

The management of LEAD involves controlling risk factors and hygienic-dietary measures, medical management (antiplatelet agents, statins, ACE inhibitors, prostaglandins, second-line analgesics, or morphine) [2], and finally surgical treatment (conventional surgery, endovascular treatment, or hybrid procedures).

Hybrid techniques, by definition, combine an endovascular procedure with a surgical intervention. This hybrid approach allows for the advantages of both techniques. Among the goals of the combined approach: intraoperative angiographic control of revascularization, screening and treatment of underlying and/or residual lesions, and the recovery of a high-quality distal bed.

#### *Objective*

Report the results and determine the role of hybrid procedures in the management of symptomatic LEAD.

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## 2. Materials and Methods

This is an extensive retrospective study over three and a half years, from January 2019 to June 2022, involving 27 patients with peripheral arterial disease of the lower limbs who underwent hybrid revascularization at the vascular surgery department of CHU HASSAN II FES.

### 2.1. Inclusion and exclusion criteria

#### 2.1.1. Inclusion criteria

After reviewing the patients' records, we selected those who underwent combined procedures.

#### 2.1.2. Exclusion criteria

The study excluded: Patients who underwent open surgery conversion after the failure of an endovascular procedure. Patients who did not undergo both procedures during the same intervention.

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## 3. Results

In our study, we performed hybrid procedures in 27 patients. The average age of our population was 67 years (range: 46 to 93 years), with a clear male predominance (74.07%). Cardiovascular risk factors were dominated by diabetes (62.96%), smoking (59.25%), and hypertension (37%). Critical limb ischemia was the most frequently reported clinical form (54%), followed by subacute ischemia in 25% of our patients and stage IV arteriopathy in 21% of cases.

As for paraclinical examinations, lower limb angiography was performed initially in 25 patients, while diagnostic arteriography was requested in 3 cases. Lesion mapping mainly involved the femoropopliteal segment (71.42%), followed by iliac involvement (35.71% of patients), and leg artery lesions in 32.14% of patients.

Therapeutic management consisted of femoral thromboembolectomy using a Fogarty catheter, followed by iliac artery angioplasty in 5 patients and sub-inguinal artery angioplasty in 3 patients.

We also performed 6 popliteal thromboembolectomy revascularization procedures. In this group of patients, the endovascular procedure was femoropopliteal-tibial artery angioplasty in 5 cases, while a common iliac artery angioplasty was performed in one case.

Femoral tripod thromboendarterectomy was performed in 6 patients. It was complemented by iliac artery angioplasty in one case and femoropopliteal-tibial artery angioplasty in the other cases.

Thrombectomy of a prosthetic graft was performed in some patients, followed by graft angioplasty in two cases, one of which received a stent placement. Only one patient underwent femoropopliteal bypass surgery in conjunction with leg artery angioplasty.

The revascularization procedure was accompanied by primary amputation in 37% of our population, mainly toe regularization (5 cases) and transmetatarsal amputations (4 cases).

Postoperative outcomes were uneventful in 81.5% of patients, and the average hospital stay was 10 +/- 2 days. However, 5 cases were complicated by hematoma at the surgical site, acute urinary retention, reversible acute renal failure, or acute ischemia.

The primary patency rate at 70.37% in our study reflects the time elapsed from the intervention to the first reintervention aimed at maintaining patency, whether by redilation in the case of stenosis or thrombectomy for complete occlusion. The assisted patency at 1 year was estimated at 59.5%, reflecting the time from the intervention to a dilation performed to maintain patency, without complete occlusion.

The secondary patency, reflecting the time between the intervention and the first necessary unblocking procedure for complete occlusion, is one year.

## 4. Discussion

The treatment of LEAD begins with hygienic-dietary measures combined with medical treatment, aimed at controlling risk factors. This includes several aspects:

**Lipid-lowering therapy:** Its prescription is supported by the REACH registry, which demonstrated that the use of statins in AOMI patients is associated with a 17% reduction in cardiovascular events. This makes the administration of statins advisable for all LEAD patients.

**Antihypertensive treatment:** The latest ESC guidelines recommend reducing blood pressure to <140/90 mmHg in AOMI patients.

### 4.1. Antithrombotic treatment

#### 4.1.1. Antiplatelet agents

In the case of lower limb arteriopathy, which defines a group of patients at high coronary and cerebrovascular risk, current recommendations advocate using aspirin as the first-line treatment and prescribing clopidogrel only in cases of digestive contraindication or aspirin intolerance.

#### 4.1.2. Anticoagulants

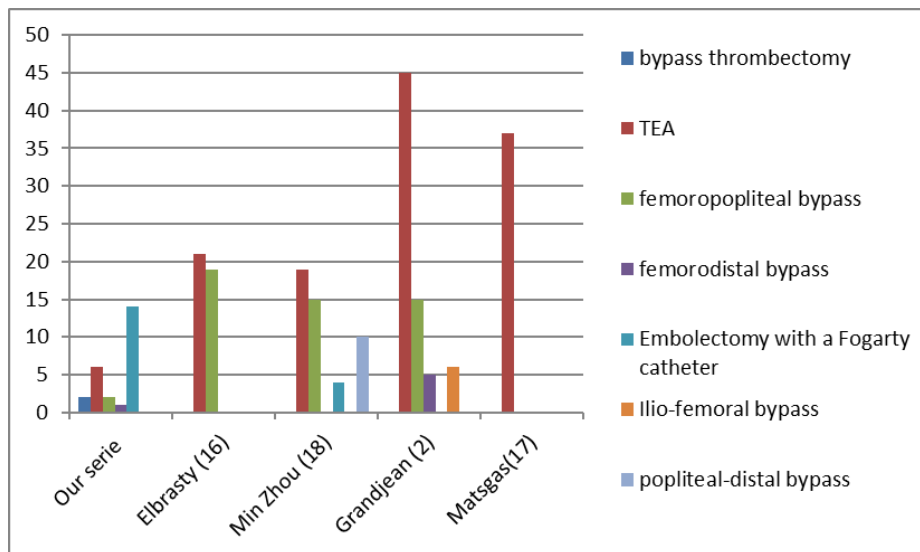
The COMPASS study showed that the combination of DOACs at a dose of 2.5 mg/12 hours and ASA 100 mg/day reduces cardiovascular mortality in AOMI patients.

**Analgesic treatment:** In the case of persistent bedridden pain, it is necessary to provide effective pain relief, with morphine if necessary.

### 4.2. Interventional treatment

#### 4.2.1. Open surgery component

In the Swiss [1], Egyptian [6], and Chinese [5] series, the most commonly performed procedure was thromboendarterectomy, with 45, 21, and 19 cases, respectively. Femoropopliteal bypass represented the second most frequently performed procedure in these three series, while our series included only one bypass. In Matsagkas et al's study, TEA was the surgical procedure performed for the entire population of the series. The chart below shows the distribution of open surgical techniques performed in some series.



**Figure 1** Surgical Procedures in Hybrid Procedures

#### 4.2.2. Endovascular procedure

In the Swiss series [1], femoral angioplasty was the most commonly performed procedure, and Matsagkas et al [7] also reported a predominance of femoral angioplasty in their series, which was often accompanied by the deployment of a primary stent. In contrast, popliteal angioplasty was the most frequently performed procedure in the study by Min Zhou et al [5].



**Figure 2** The distribution of endovascular procedures performed during hybrid procedures in various series

Characteristics	Total
Patient	27
Average age	67 YEARS ( 46 Years – 93 Years)
Male	20 ( 74,08 %)
Tobacco	16 ( 59,25 %)
High blood pressure	10 ( 37,03 %)
Diabetes	17 ( 62,97 %)
Dislypedimia	02 ( 7,40%)
Ischemic heart disease	04 ( 14,80%)
Valvular heart disease	01 ( 3,70%)
Undocumented heart disease	02 ( 7,40%)
Ischemic stroke	03 (11,11%)
Undocumented renal failure	01 ( 3,70%)
Hyperthyroidism	01 ( 3,70%)
Follow-up of LEAD	09 ( 33,33 %)
Interventional treatment of LEAD	08 ( 29,62 %)
CCLI	14 ( 51,80 %)
LEAD grade 4	06 ( 22,20 %)

**Figure 3** Clinical data of patients in our study

Post-operative complications :	Total :
surgical site haematoma	02 (7,40%)
acute retention of urine	01 (3,70%)
reversible renal failure	01 (3,70%)
acute post-operative ischaemia in the medium term	01 (3,70)

**Figure 4** Post-surgery complications

#### 4.2.3. Associated Procedures:

In addition to revascularization procedures, several additional procedures were performed based on the trophic disorder presented by the patient. In our series, we recorded 10 minor amputations and only one major amputation (above-the-knee amputation). These numbers were lower compared to the Elborasty et al and Matsagkas et al series. This result can be explained by delayed patient care in our series.

**Table 1** Distribution of adjuvant procedures performed on patients who underwent hybrid procedures.

Gesture associated with the hybrid	Elborasty Et al [18]	Matsagkas et al [19]	Notre étude
Minor			
amputation of toe	1	6	5
amputation of the forefoot	2	1	4
Chopart	0		1
Major			
amputation of leg	0		1
Nécrosectomy \ debridement	2	2	2
Total	5	9	13

### 4.3. Evolution and Complications

#### 4.3.1. Primary Success

Technical success is judged based on intraoperative angiographic images. In our study, the technical success rate was 95%. This result was more or less similar to the rates reported in other studies. It was around 93.22% in the Egyptian study [6], 96.7% in the Greek study, while a 100% success rate was reported in the Grandjean [1] and Min Zhou [6] series.

#### 4.3.2. Postoperative Complications

Numerous studies published in the past fifteen years on the treatment of LEAD lesions using hybrid procedures report excellent rates of primary technical success and morbidity-mortality [8]. Min Zhou et al [5] reported complications such as infection and hematoma at the surgical site, stroke, and myocardial infarction in only one case each. In contrast, in the Swiss series [1], postoperative complications were mainly local, with wound infection observed in 9 patients, surgical site hematoma in 4 cases, and cardiac complications in 5 patients. In the Elborasty et al [18] series, local complications were predominant, with 3 cases of surgical site infections and one case of hematoma. They also reported postoperative acute ischemia and acute renal failure in one case each. Additionally, a Scarpa pseudoaneurysm was reported in only one case.

#### 4.3.3. Deaths

No deaths were reported in either our series or the group of patients treated with hybrid procedures in the Min Zhou et al [5] series. In the Egyptian study [4], two deaths were recorded, one due to a myocardial infarction and the other due to a stroke. The Swiss series from CHUV Lausanne [1] recorded ten deaths, two related to cardiac complications,

and the other eight due to conditions unrelated to LEAD. In general, according to several studies, hybrid procedures are characterized by low perioperative morbidity and mortality, good primary patency rates, and medium-term outcomes [9].

#### 4.3.4. Length of Hospital Stay

Regarding the length of hospitalization in our series, we observed an average stay of 10 days +/- 2 in the department. The average stay in the intensive care unit was 2 days +/- 1 for the 7 patients who required postoperative intensive care unit admission. This result is consistent with that of the Grandjean et al [1] series, which reported a hospital stay of 12 days but is higher than the findings of other studies, such as those of Elborasty et al [6] and Matsagkas et al [5].

The table below summarizes the complications and patient outcomes in the previously mentioned series.

**Table 2** Postoperative complications and outcome of patients who underwent hybrid procedures according to selected series.

	Grandjean et al[1]	Matgaskas Et al[7]	Elborasty et al [6]	Min Zhou et al [5]	Our study
technical success:	100%	96.7%	93.22%	100%	95%
minor complication: hematoma	4	-	1	1	2
InfectionLymphorée	9	-	3	1	-
major Complication :	-	1	2	1	-
cardiac complication	5	1	1	1	-
cerebral complication	1	-	1	1	1
death	10	Aucun	2	Aucun	Aucun
hospital stays	12	5	6	-	10+/-2
Primary permeability at 6 months	68%		72%	93.2%	70.37%

## 5. Conclusion

The progress in hybrid procedures has expanded the possibilities for revascularization in patients with severe and complex arterial lesions. These techniques provide an excellent alternative for specific indications, thanks to their satisfactory results in terms of primary success, long-term patency rates, and, consequently, limb salvage rates [10].

### Compliance with ethical standards

#### *Disclosure of conflict of interest*

No conflict of interest.

#### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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