Arterial perforation during lower limb percutaneous transluminal angioplasty for treating critical lower limb ischemia

Islam Atta[a], Samy Zekilah[b], Amr El Abd[c], Haitham Fouda[d], Ahmed Sawaby[e]

Departments of [a]Vascular Surgery, [d]Radiodiagnosis, Faculty of Medicine, Kafrelshakh University, Kafrelshakh, [b]Department of Vascular Surgery, Ministry of Health, Elbahera, Egypt, [c]Department of Radiodiagnosis, Faculty of Medicine, Alexandria University, Alexandria, [e]Department of Vascular Surgery, Faculty of Medicine, Port Said University, Port Said, Egypt

Correspondence to Islam Mohamed Nabil Soliman Atta, MD of Vascular Surgery, 40 khalil Motran Street, Saba Basha, Alexandria, 33511, Egypt. Tel: 01222751703; e-mail: islamatta81@gmail.com

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Purpose
To manage infrainguinal arterial perforation during percutaneous transluminal angioplasty (PTA) by different methods and to determine the incidence of occurrence of this complication in our patients.
Patients and methods
This study was performed on 20 patients of 295 patients with 399 lesions who developed arterial perforation during PTA for treatment of critical lower limb ischemia.
Results
Median age of patients was 69.5 years, with 11 (55%) males. A total of 16 (80%) patients were diabetics, 14 (70%) patients were hypertensive, and 16 (80%) patients were smokers. Overall, seven (35%) patients had rest pain and 13 (65%) patients had ulcers or gangrene. Long-time balloon inflation was done for 15 (75%) patients. It succeeded to stop bleeding in 13 patients, and two patients underwent surgical intervention. External compression was done for five patients with tibial perforation and succeeded to stop bleeding. Overall, 17 (85%) patients of 20 patients had calcifications in their arteries. The incidence of arterial perforation in our patients in relation to the total number of patients was 6.7%, and the incidence of arterial perforation in the treated lesions in relation to the total number of lesions was ~5%. At the end of the procedures, 18 (90%) patients had no active extravasation with forward dye flow and during the follow-up period also. The other two patients underwent surgical intervention.
Conclusion
PTA is a valuable option for treatment of critical lower limb ischemia. Although complications like perforation may happen, early recognition and management is crucial and mostly perforation can be managed properly by endovascular procedures.

Keywords:
arterial perforation, critical lower limb ischemia, percutaneous transluminal angioplasty

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Introduction

Percutaneous balloon angioplasty [percutaneous transluminal angioplasty (PTA)] for treating peripheral arterial diseases is increasing recently replacing open surgical techniques in many patients. Owing to the usage of catheters and guide wires during navigation through the vessels, the incidence of arterial perforations increases during these procedures. However, endovascular percutaneous procedures demonstrated less than 1% overall major complications with shorter hospital stay. Risk factors for arterial perforation can be classified into modifiable risk factors like usage of larger sheath sizes, high angioplasty pressures, redundant guide wire manipulation, longer procedure time, long term use of steroid therapy, and usage of anticoagulation and thrombolytics. Nonmodifiable risk factors are arterial calcifications with its predisposing factors (diabetes mellitus, hypertension, and chronic renal failure), excessive arterial tortuosity, high grade stenosis, and anatomic arterial variants especially when utilizing straight tipped wires [1–7].

The most common locations for arterial access are the radial and femoral approaches. Generally radial approach is preferred than femoral approach owing to less access site bleeding, definitive hemostasis with quicker patient mobilization. Complications associated with arterial perforation include hematoma, pseudoaneurysm formation, vessel spasm, arteriovenous fistula, and distal ischemia owing to thrombosis and/or dissection. Femoral approach can lead to retroperitoneal hematoma formation, which may be life-threatening; however, both approaches can lead to major vessel injuries, with resultant fatal

bleeding and distal ischemia, so early recognition and management is the key to treat these complications [1,5,6,8].

Antegrade femoral access may be used for treating femoropopliteal or tibial diseases. Femoral access puncture is preferred in common femoral artery than superficial femoral artery (SFA) as compression can be undertaken efficiently against femoral head after procedure. However, SFA access may be preferred for morbid obese patients or patient with contraindication for common femoral artery puncture like recent surgeries at this site. Regarding perforation in SFA, this may be managed by prolonged balloon inflation using low pressure for 2–4 min, as this gives time for hemostasis process to start and to stop bleeding; if it failed, self-expanding covered stent may be used to control bleeding. If perforation was from side branch and the previous methods failed, coil embolization may be considered [9,10].

Arterial perforation that occurs during tibial angioplasty may occur during guide wire manipulation through these small vessels especially when it is excessively calcified with long occluded segments or it may occur during balloon angioplasty. Early detection of arterial perforation is crucial as it may result in large hematoma formation and compartment syndrome if neglected. Arterial perforation may be managed simply by external compression of the leg, especially if this perforation occurs before angioplasty. Balloon angioplasty for 3–5 min with low pressure may also be considered. Lastly, if perforation was through perforation of a side branch with failure of the previous procedures, coil or foam embolization may be the treatment of choice for treating this perforation [11].

The increasing numbers of endovascular procedures nowadays owing to their less comorbidities relatively than open surgical procedures have led to an increase in the number of arterial complications like vessel perforation, so proper management of this problem is crucial. This study was performed to discuss different methods for treating infrainguinal arterial perforation during PTA for the lower limb arteries.

Patients and methods

After taking a written consent from patients, this study was conducted in the period between March 2019 and April 2020. After taking a written consent from patients and its acceptance by Alexandria university ethical committee. It was performed on 20 patients of 295 patients with 399 tight lesions who underwent PTA for treating critical lower limb ischemia (CLI), and they unfortunately developed arterial perforation during the procedure. This was a multicentric study in multiple vascular centers in Egypt.

All patients were subjected to detailed history taking regarding peripheral vascular disease symptoms like intermittent claudication, rest pain, and gangrene. History of chronic illnesses like diabetes mellitus, hypertension, chronic kidney disease, and coronary artery disease and history of smoking were taken. Full examination was done for all patients with detailed vascular examination for lower limb pulses with measuring ankle–brachial index. Full laboratory tests were done (complete blood count, urea, creatinine, SGOT, SGPT, prothrombin time, international normalized ratio, serum cholesterol, triglycerides, and glycated hemoglobin). Detailed arterial duplex and computed tomography angiography were done for all patients to diagnose site(s) and number(s) of arterial stenosis or occlusion.

All patients had arterial perforation either in SFA, distal SFA, and popliteal (femoropopliteal) or tibial arteries during the procedure which was documented by the extravasation of the dye. This was managed primarily by inflation balloon with low pressure for 3–5 min; if this failed, a covered stent was inserted if available. For tibial vessels also external compression was done in many cases trying to stop bleeding. Lastly, surgical repair was undertaken if endovascular management failed or for financial purposes (Figs 1–3).

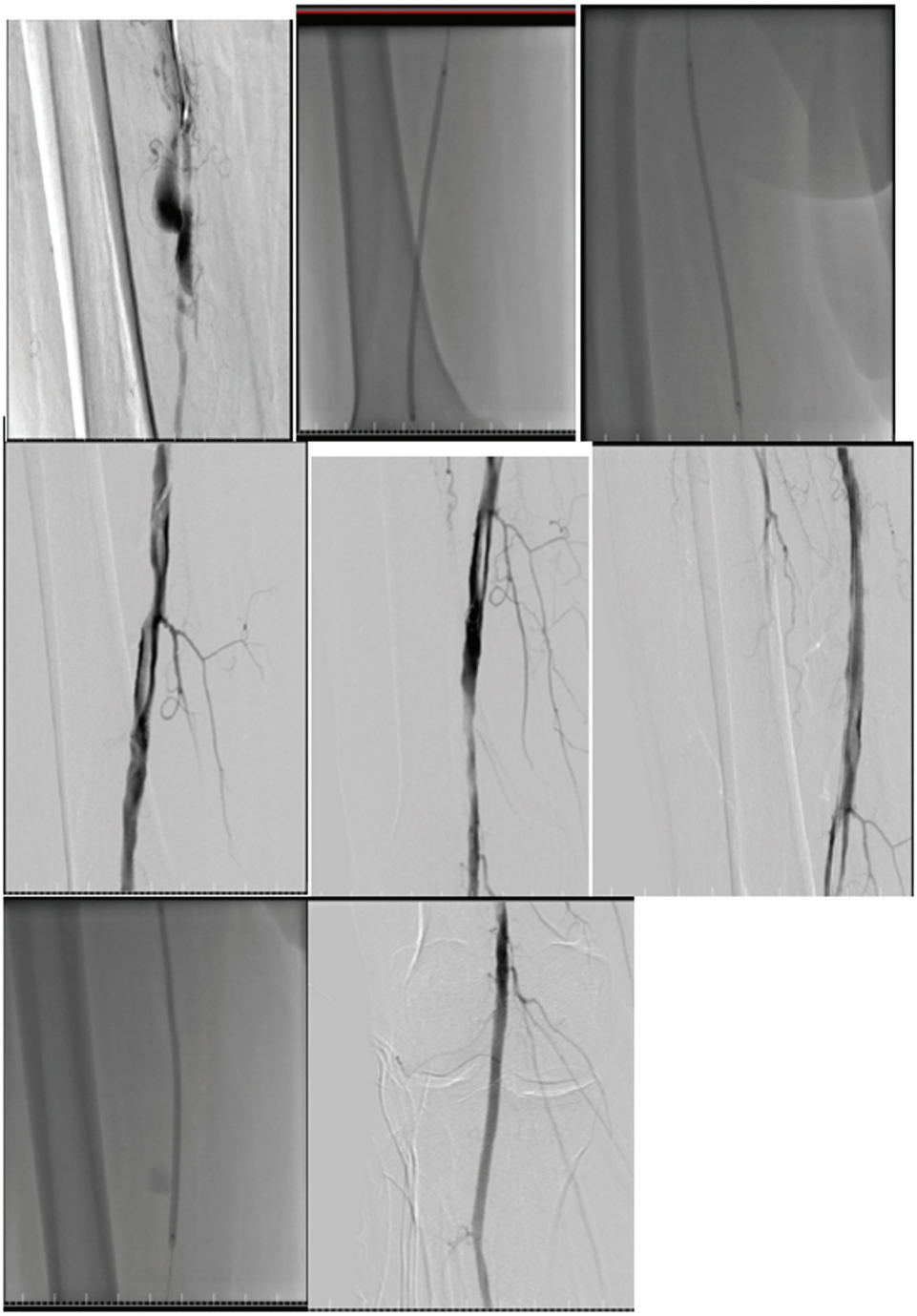
End point

Angiography was repeated to ensure that there is no active extravasation or leak and there was forward unrestricted dye flow with no significant stenosis. Follow-up was done on discharge, 1 week, 1, 3, and 6 months later. Clinical examination and arterial duplex were done to ensure patency of the arteries with no significant hematoma, pseudoaneurysm, or arteriovenous fistula.

Results

This study was conducted on 20 patients out of 295 patients with 399 tight lesions. These patients were complaining of CLI and developed arterial perforation during PTA of tight lesions. Their ages ranged between 49 and 83 years, with a median of 69.5 years. There were 11 (55%) males and nine (45%) females. Regarding risk factors, 16 (80%) patients were diabetics, 14 (70%) patients hypertensive, 10

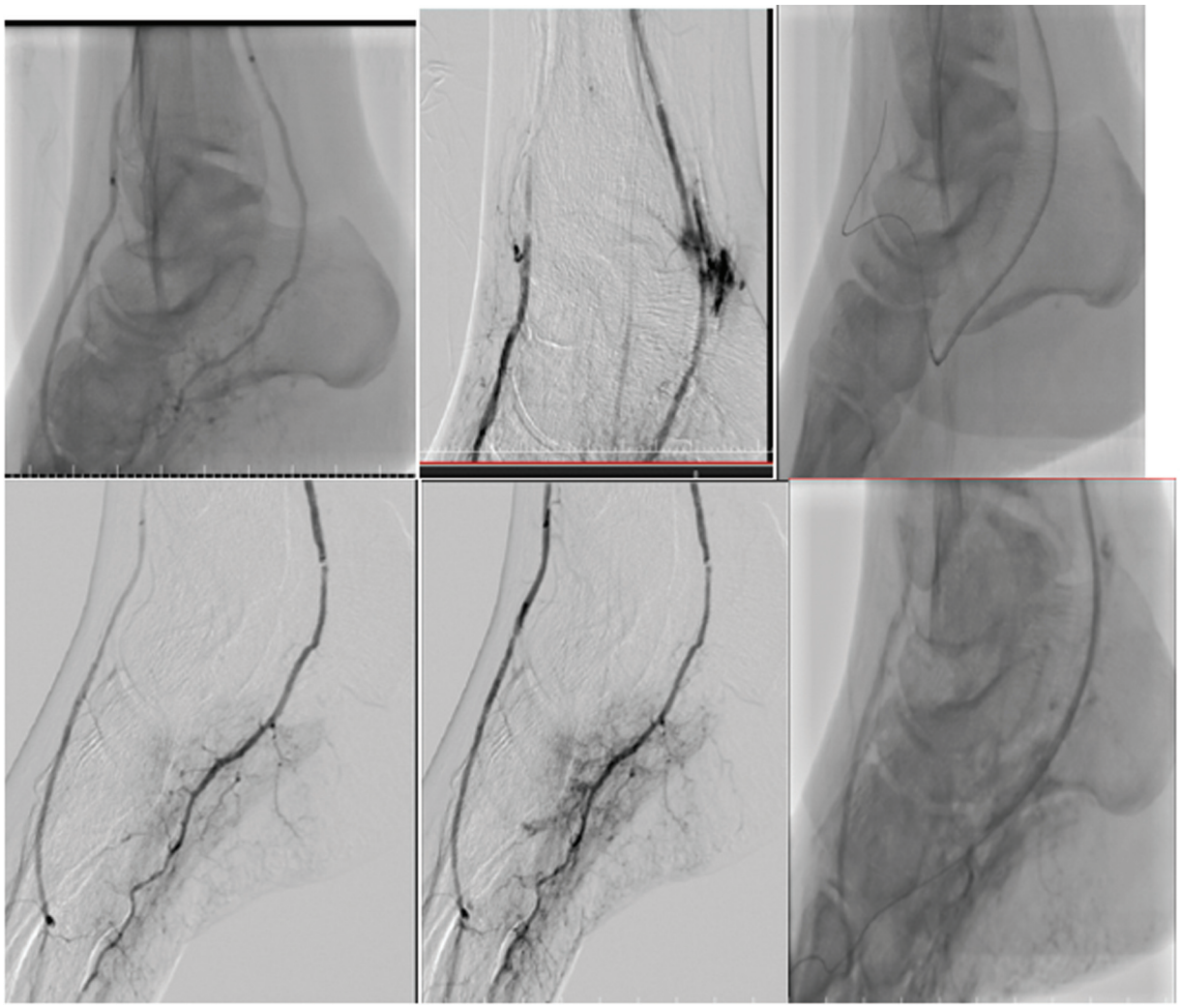
Figure 1



SFA perforation and dissection managed by long-time balloon inflation and stenting. SFA, superficial femoral artery.

(50%) patients had dyslipidemia, and 16 (80%) patients were smokers. Seven (35%) patients were complaining of rest pain, and 13 (65%) patients were complaining of trophic changes like foot ulcer and gangrene. Regarding the site of the disease, six (30%) patients had femoropopliteal disease, nine (45%) patients had tibial disease, and five (25%) patients had both SFA and tibial diseases. Long-time balloon inflation was done for 15 (75%) patients; it succeeded to stop bleeding in 13 patients, and two patients underwent surgical intervention like femoral popliteal bypass or open repair with evacuation of the hematoma (Fig. 3). External compression was done for five patients (all were tibial disease) and succeeded to stop bleeding in the five patients. Overall, 17 (85%) of 20 patients who were complaining of arterial perforation during PTA of their arteries had calcifications in their arteries, and most of them were diabetics and smokers (Table 1). So, the incidence of arterial perforation in our patients in relation to the total number of patients was 6.7%, and the incidence of arterial perforation in the treated tight lesions in relation to the total number of lesions was ~5%.

Figure 2



Posterior tibial artery perforation managed by inflation balloon.

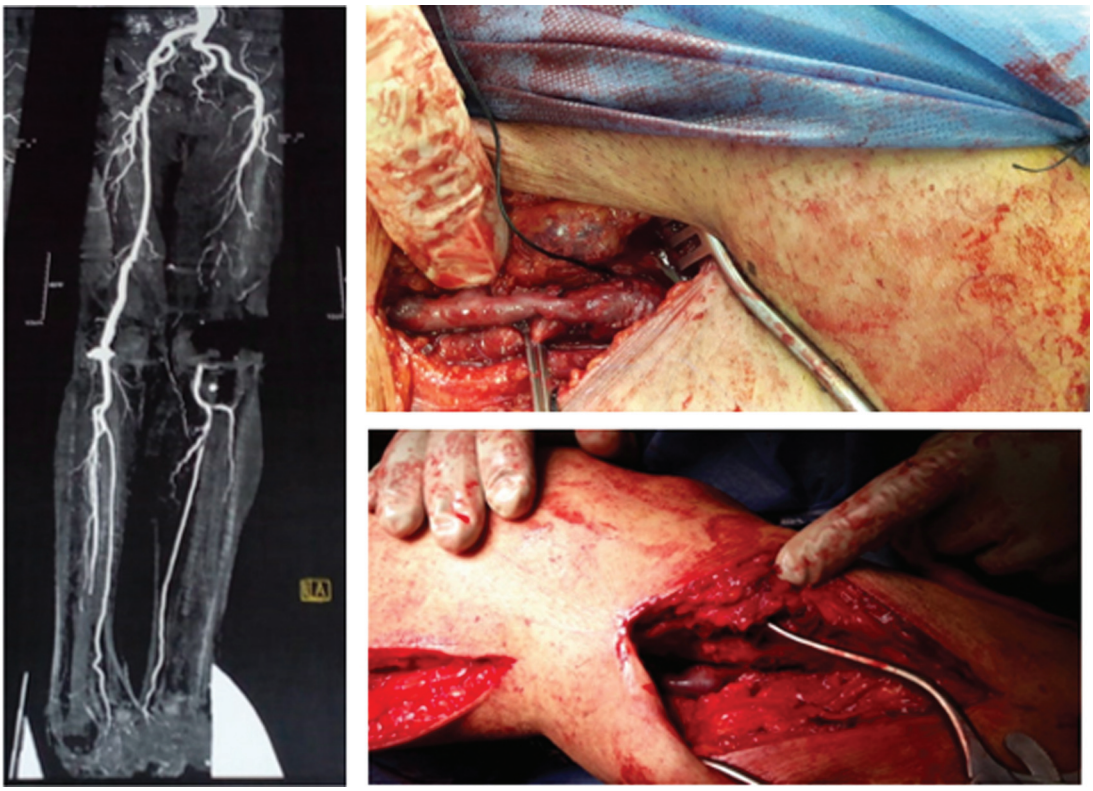
For managing the perforation, 18 (90%) patients had no active extravasation at the end of the procedures with forward unrestricted dye flow and during the follow-up period also. Active extravasation was revealed in two (10%) patients, which was managed surgically by doing a bypass in one patient and surgical repair in the other one with evacuation of the hematoma. During the follow-up period, there was no extravasation, with good forward flow (Table 2).

Discussion

Many studies have been performed for assessing and evaluating different methods for treating arterial perforation during PTA for lower limb arteries and calculating its incidence. In the current study, different methods (according to the available facilities) are discussed for treating this complication and determining the rate of its occurrence in our patients, with comparison of our data with others.

Papavassiliou *et al.* [12] had performed PTA for 1053 segments in 550 patients (338 males and 212 females). The indication for angioplasty was CLI in 148 (27%) patients, intermittent claudication in 396 (72%) patients, and it was not recorded in six (1%) patients. Regarding the incidence of occurrence of early complications which was related to the PTA, it was about 14%, and most of them were managed by endovascular procedures (97%), and surgery was needed in only 0.5% of all patients. Arterial perforations occurred in 26 (2.5%) segments of 1053 segments. In the current study, all patients who entered the study were complaining of CLI, and the incidence of occurrence of perforation was ~5% from the total treated segments. This difference in the occurrence of perforation may be related to the more aggressive nature of lesions which were faced in our patients, as they were all complaining of CLI which needed more aggressive procedures to save the limb. Only two patients needed surgical intervention like open repair

Figure 3



Femoral popliteal bypass infragenicular using reversed saphenous vein after perforation of distal SFA and proximal popliteal artery during PTA. PTA, percutaneous transluminal angioplasty; SFA, superficial femoral artery.

in one patient and femoral popliteal bypass in the other patient, and the rest of our patients were managed either conservatively or by endovascular techniques [12].

Hayes *et al.* [13] had performed PTA for 1409 patients (878 men and 531 females). A total of 991 (70.3%) patients were complaining of claudication and 418 (29.7%) patients were complaining of CLI. The incidence of arterial perforation was ~3.7% (52 patients). In 29 patients, their perforation was mild and it resolved without any intervention, 15 patients needed coil embolization, six patients needed long balloon inflation, and two patients needed both balloon inflation and coil embolization. So, the incidence of arterial perforation is nearly similar to the current study, which was 5%. This little increase of perforation occurrence in the current study may be owing to all our patients had CLI as mentioned before. In the current study, long-time balloon inflation was done for 15 (75%) patients; it succeeded to stop bleeding in 13 patients, and two patients underwent surgical intervention. External compression was done for five patients (all were tibial disease) and succeeded to stop bleeding in the five patients; unfortunately, coils were not available for our patients owing to financial issues [13].

Sharaby *et al.* [14] had performed their study on 65 patients who were complaining of chronic lower limb ischemia (39 males and 26 females). A total of six (9.2%) patients were younger than 50 years, 20 (30.8%) patients between 50 and 60 years, and 39 (60%) patients were older than 60 years. Regarding risk factors, 49 (75.4%) patients were diabetics, 35 (53.8%) patients smokers, 47 (72.3%) patients hypertensive, and ischemic heart disease was seen in 25 (38.5%) patients. Three (4.6%) patients were complaining of intermittent claudication and 62 (95.4%) patients were complaining of CLI. Complications that occurred during PTA were dissection in 35 patients, perforation in 20 patients, thrombosis in six patients, and arteriovenous fistula in four patients. Perforation was managed successfully by long-time inflation balloon in 17 patients, covered stent in one patient, surgical ligation of the artery in one patient, and surgical bypass in the last patient. Age of our patients in the current study ranged between 49 and 83 years, with a median of 69.5 years. There were 11 (55%) males and nine (45%) females. Regarding risk factors, 16 (80%) patients were diabetics, 14 (70%) patients hypertensive, 10 (50%) patients had dyslipidemia, and 16 (80%) patients were smokers. Seven (35%) patients were complaining of rest pain, and 13 (65%) patients were complaining of trophic changes like foot ulcer and gangrene. Regarding the

Table 1 Distribution of the studied cases according to different parameters (*N*=20)

	n (%)
Age (years)	
<60	2 (10)
≥60	18 (90)
Mean±SD	69.8±8.8
Median (minimum–maximum)	69.5 (49–83)
Sex	
Male	11 (55)
Female	9 (45)
Risk factors	
DM	16 (80)
HTN	14 (70)
Dyslipidemia	10 (50)
Smoking	16 (80)
Symptoms	
Rest pain	7 (35)
Foot ulcer and gangrene	13 (65)
Number of lesion(s) in the same lower limb	
One lesion	15 (75)
Two lesions	5 (25)
Site of the disease	
Femoropopliteal disease	6 (30)
Tibial disease	9 (45)
SFA and tibial disease	5 (25)
Management of perforation	
External compression	5 (25)
Long-time balloon inflation	15 (75)
Calcifications	17 (85)
Need for surgical intervention (open repair or bypass)	2 (10)
Complications after endovascular management of perforation	
None	18 (90)
Large hematoma which necessitates evacuation and arterial repair	2 (10)

DM, diabetes mellitus; HTN, hypertension; SFA, superficial femoral artery.

site of the disease, six (30%) patients had femoropopliteal disease, nine (45%) patients had tibial disease, and five (25%) patients had both SFA and tibial diseases. Long-time balloon inflation was done for 15 (75%) patients; it succeeded to stop bleeding in 13 patients, and two patients underwent surgical intervention like femoral popliteal bypass in one patient and open repair with evacuation of the hematoma in the other patient. External compression was done for five patients (all were tibial disease) and succeeded to stop bleeding in the five patients. So, the current study results is comparable with the results of Sharaby *et al.* [14].

Conclusion

PTA is a valuable option for treating CLI, although complications like perforation may happen especially in elderly diabetic patients with highly calcified arteries.

Table 2 Comparison between the different periods according to perforation

Perforation	Follow-up at the end of the procedure [*n* (%)]	Follow up [*n* (%)]			
		1 week	1 month	3 months	6 months
No extravasation	18 (90)	20 (100)	20 (100)	20 (100)	20 (100)
Active extravasation	2 (10)	0	0	0	0

Early recognition and management is crucial, and mostly perforation can be managed properly by endovascular procedures.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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