OPENAIMJ ORIGINAL ARTICLE

Vascular Surgery

Management of Procedure Specific Complications during Percutaneous Transluminal Angioplasty for Lower Limb Ischemia

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Received for publication, *March 17, 2020;* ***Accepted***, *July 13, 2020;* ***published online***, *July 13, 2020.*

doi:10.21608/aimj.2020.25111.1161

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Abstract

Background: Percutaneous transluminal angioplasty (PTA) has become the first-line option in the treatment of lower limb ischemia.

Objective: is to evaluate the management procedures during percutaneous transluminal angioplasty of lower limb ischemia

Patient and Methods: Sixty five patients with manifestations of lower limb ischemia underwent for percutaneous transluminal angioplasty and had developed critical situations during the procedure. In the vascular surgery departments in Al-Hussein university hospital and Agouza police from March 2018 to March 2020.

Results: Study on 65 patients showed that; they developed 67 complications. Complications reported were; Dissection in 35 cases (53.8%), Perforation in 20 cases (30.8%), Thrombosis in 6 cases (9.2%). While in 4 cases (6.2%) Arterio-venous fistula has developed and in 2 cases (3.1%) there was a residual stenosis.

Most of cases were managed by endovascular approach in 61 cases (93.8%) but 4 cases (6.2%) were managed by surgical methods.

Most of cases had saved their limbs and avoided major amputations unless two cases were gone for major amputations. There was no immediate mortality.

Conclusion: Critical situations during endovascular interventions are affected by risk factors, clinical presentation, morphological lesion and type of intervention. Most of cases could be managed by endovascular procedures.

Key words: Endovascular; critical situations; dissection; limb salvage.

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*

INTRODUCTION

The treatment of lower limb ischemia has changed dramatically because of the explosion of catheter-based interventions. In recent years, percutaneous transluminal angioplasty (PTA) has become the first-line option in the treatment of lower limb ischemia as it allows the healing of ulcers, diminution of rest pain and improvement of claudication distance with low complications.[1,2]

As in every therapeutic procedure, endovascular procedures such as angioplasty and stenting carry an inherent risk of complication to the patient. Though with the proper training these complications can usually be successfully managed endovascularly, improper management may lead to emergency surgery, limb loss, functional disability, and death. It is paramount that physician operators have the proper training and ability to anticipate and recognize complications as they arise during endovascular procedures.[3]

Acute vascular complications at the endovascular procedure site include arterial perforation, dissection, arteriovenous fistulas, thrombosis, spasm, side branch occlusion, and equipment failure.[4]

PATIENT AND METHODS

Sixty five patients with manifestations of lower limb ischemia, underwent for percutaneous transluminal

angioplasty and had developed critical situations during the procedure. All primary procedures were done under local anesthesia in the angio suit at the vascular surgery department in AL-Hussein university hospital and Agouza police hospital from March 2018 to March 2020.

The main objective of this study is to evaluate the results of management procedures for critical situations that happened during percutaneous transluminal angioplasty of lower limb ischemia.
Patients included in this study were suffering from lower limb ischemia with Rutherford class 3 to 6 clinically, with any morphological lesion according to TASC II classification and underwent complications during PTA.
But patients excluded from this study who were unsuitable for angioplasty as Renal insufficiency, Contrast allergy. PTA procedures without complications and procedures with late complications.
All patients underwent evaluation by complete history taking about personal data, Risk factors (smoking, DM, hypertension, hyperlipidemia), Co-morbidities (previous stroke, angina, MI and CKD), previous PAD interventions to one or both legs, previous amputation, history of presenting symptom (rest pain or tissue loss) and previous coronary intervention (CABG, PCI).Rutherford class 3 to 6 clinically.

All patients presented subjected to detailed clinical evaluation for avoidance of contrast allergy, complete laboratory assessment for avoidance of renal insufficiency, complete cardiac assessment by Echo Doppler for avoidance of heart failure, and arterial duplex ultrasound imaging study and CT angiography of both lower limbs for diagnosis and assuring the preparation.

Management procedures :
All interventions were done in angio suite under local anesthesia. The management of complications were depended on the disease location and the type of complications.
For Residual stenosis ≥30% balloon dilatation by lager diameter balloon was done and stenting was done in cases of failed angioplasty.
For dissections balloon dilatation by lager diameter balloon was done for long time 3 mins then completion angiography was done and stenting was done in cases of failed angioplasty (residual flow limiting dissection).
But for perforations large compliant balloon was inflated for 3 to 5 mins for cases with ruptured vessels; covered stent, surgical bypass and life saving ligation of the artery in case of failed control.
For thrombosis; thrombectomy was done during the angioplasty by fogarthy over the wire or suction of the fresh thrombus by bern catheter,some cases were managed by angioplasty and open surgical thrombectomy was done in 2 cases.
In cases with developed AVF prolonged balloon inflation at the site of AVF for 3:5 mins, then angiography was done to confirm closure of the fistulae.

All were studied for immediate complications that occur during the percutaneous transluminal angioplasty of lower limb arteries and need bailout procedures to save the limb or the patient; this complications included puncture site complications, Residual stenosis ≥30%, Flow-limiting Dissection, Perforation or Rupture, Thrombosis, stent
In arterial spasm vasodilator agent (nitroglycerine, papaverine, and verapamil) were administered and the guide wire have to be removed to distinguish refractory spasm from dissection.
The endpoint of the procedure was unrestricted forward flow of contrast with no evidence of significant (>30%) residual stenosis. The run-off was assessed at the end of the procedure for the occurrence of distal embolization caused by the PTA or stent insertion .
Primary outcomes: Technical success: Arterial patency to the lower limb known by presence of antegrade blood flow through the lesion at the end of the procedure.
Secondary outcome parameters are the Clinical response that can be known from improvement of symptoms and the hemodynamic success which is defined as an increase in ankle brachial index of 0.10 to 0.15 or greater.

RESULTS

The current study was a prospective randomized controlled study that conducted on 65 patients complaining lower limb ischemia; 39 (60%) males and 26 (40%) females. Patients with age less than 50 years old was 6 (9.2%), from 50 to 60 years old were 20 (30.8%) but patients older than 60 were 39 (60%) of all patients in the study who were collected from vascular surgery department in AL-Hussein university hospital and Agouza police hospital.
According to the risk factors and co-morbidities of the patients in the study; 49 (75.4%) were diabetic, 35 (53.8%) were smokers,47 (72.3%) were hypertensive, 25 (38.5%) with ischemic heart disease, 7 (10.8%) had a previous stroke and 30 patients (44.8%) had more than 2 risk factors and co-morbidities.
As regard symptoms presented by the patients in the study; 3 patients were complaining sever claudication (disabling claudications) that harm their life style (Rutherford category 3), 12 (18.5%) presented with ischemic rest pain (Rutherford category 4), 31 (47.7%) presented with minor tissue loss (Rutherford category 5), 19 29.2%) presented with major tissue loss (Rutherford category 6)

According to primary lesion morphology in this study; Iliac lesions TASC A no cases, TASC B one case 20%, TASC C 3 (60%), TASC D single case (20%). Femoral lesions no cases of TASC A, 6 (21.5%)cases with TASC B lesion, TASC C 13 (46.5%) and TASC D 9 (32%). Popliteal artery lesions were: no cases with TASC A and C, TASC B 4(25%)and TASC D 12(75%). Tibial lesions were : TASC A 1(6.25 %) , TASC B 2(12.5 %) ,TASC C 6(37.5%) and TASC D 7(43.75%). Over all 1.5% of TASC A , 20% of cases had TASC B lesions,

33.8% of patients had TASC C lesions , 44.6% of Complications that happened during endovascular intervention classified according to site of complication into; Iliac 5 (7.7%), SFA complications ware 28 (43.1%), popliteal artery complications 16 (24.6%) and complications that happened in tibials were 16 (24.6%).
The critical situations that happened during endovascular intervention were classified according to type into; Dissection 35 (53.8%), Perforation 20 (30.8%), Thrombosis 6 (9.2%), 4 (6.2%) cases with early Arteriovenous fistula and 2 (3.1) cases of residual stenosis. Two cases developed more than one type of complications during intervention) Dissection and perforation). Most of cases were managed endovascular 61 (93.8%) but 4(6.2%) cases managed by surgical methods.

In 65 cases developed critical complications; 63 (96.6%) cases had saved their limbs and avoided major amputations and two cases were gone for major amputations. In this study there was no immediate mortality.
In this study there were 35 cases of dissection distributed according to site; Iliac 3(8.5%), SFA 21 (60%), POP 10 (28.5%) and tibials one case (2.9%). 20 cases of perforation 13 of them (65%) in tibial arteries and 7 (35%) in tibial arteries. 6 cases of thrombosis; 2 of them (33.3%) in pop artery and 4 cases (66.6%) were in SFA. 4 cases developed AVF; 2 (50%) were in pop artery and 2 (50%) in tibial arteries. 2 cases of residual stenosis were in iliac arteries.
Two cases were gone for above knee amputation; one case of SFA perforation that failed to be managed by endovascular tools and managed by ligation of the femoral artery as a lifesaving procedure. The other case was case of SFA thrombosis and the open thrombectomy was failed and the patient had bad general conditions (EF 30%) with diseased out flow vessels.
Dissection was the most common type of complication in this study 35 cases 3 of them (8.5%) were in iliac arteries; 2 cases (66.7%) were managed by stenting and one case (33.3%) was managed by balloon. In SFA 21(60%); 18 (82.7%) of SFA patients had TASC D- as in table (2) dissections were managed by stenting and 3(14.3%) were managed by balloon inflation. Pop dissections were 10 (28.5%) cases; 8 (80%) were managed by balloon inflation and 2 cases (20%) were managed by stenting with bare metal stent (supera stents weren't available). Only one case developed critical flow limiting dissection in tibial arteries and managed by long standing inflation balloon 3-5 mins
As regard perforation; 10 cases of perforation 3 of them were in tibials and 7 cases were in SFA.
In SFA cases; 4 (57.1%) managed by balloon inflation, one case (14.1%) was managed by covered stent, one case (14.1%) was managed by surgical bypass after failure of endovascular management and one case (14.1%) failed to be managed by endovascular tools and managed by ligation of the artery for life saving. In tibials all cases (100%) of perforation were successfully managed by long inflation balloon.
In this study 6 cases of critical thrombosis 4 of them were in pop artery and 2 cases were in SFA. Cases of SFA thrombosis; one case was managed by thrombolytic therapy and one case was managed by surgical thrombectomy 50% for each method. Cases of pop thrombosis were managed by; surgical thrombectomy one case 25%, angioplasty one case 25% and 2 cases were managed by suction catheter.
As regard AVF that occurred during interventions; 2 cases were developed between pop artery and vein and 2 cases in tibials all cases successfully managed by long inflation balloon and the fistulae were closed.
In this study there were two cases of critical residual stenosis. The 2 cases were in iliac arteries and successfully managed by stenting with limb salvage 100%.
Upon review of the management procedure there were primary outcome parameters; technical success was reported in 63 (96.9%) of cases. Clinical response in 60 (92.3%) and haemodynamic success in 61 cases (93.8%). And 4 (6.1%) managed surgical. Study interventions and findings are in (Figures 1-12) and (Tables 1-7).

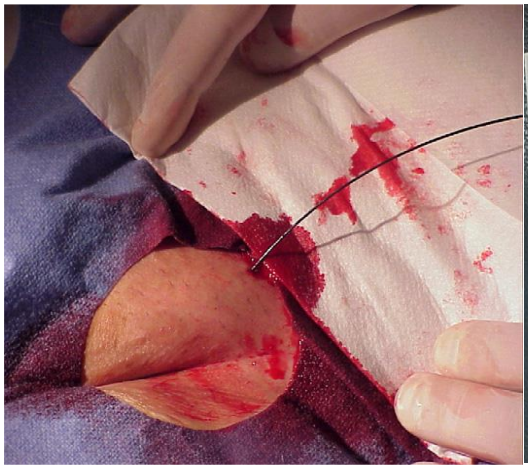

Fig. 1: Femoral axis

Fig. 2: Sheath 6F

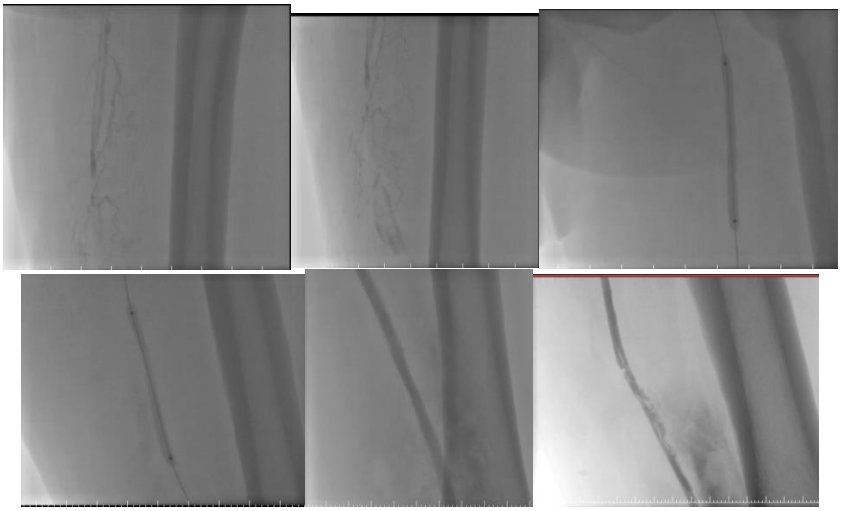

Fig. 3: Case of SFA dissection and perforation managed by balloon that couldn't manage the large dissection.

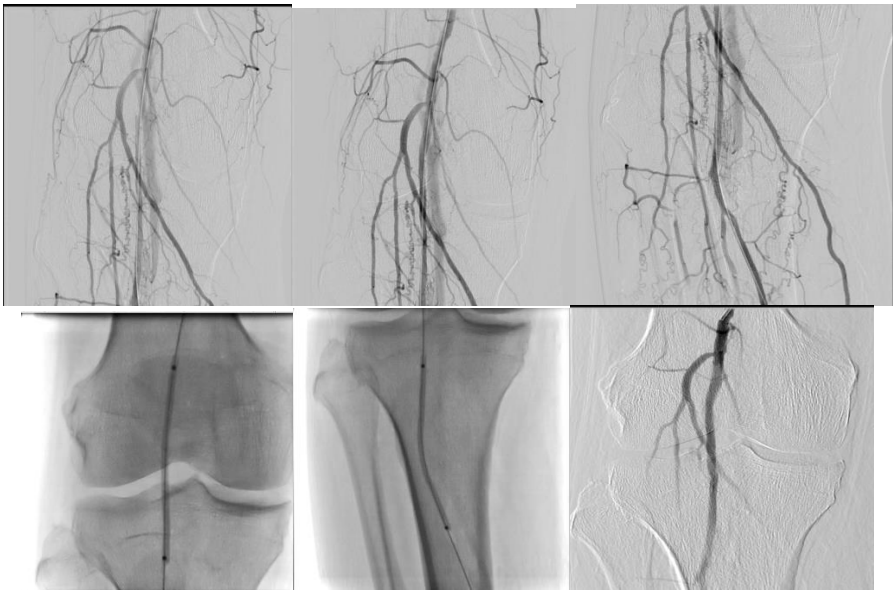

Fig. 4: A case of popliteal fistula managed by balloon inflation.

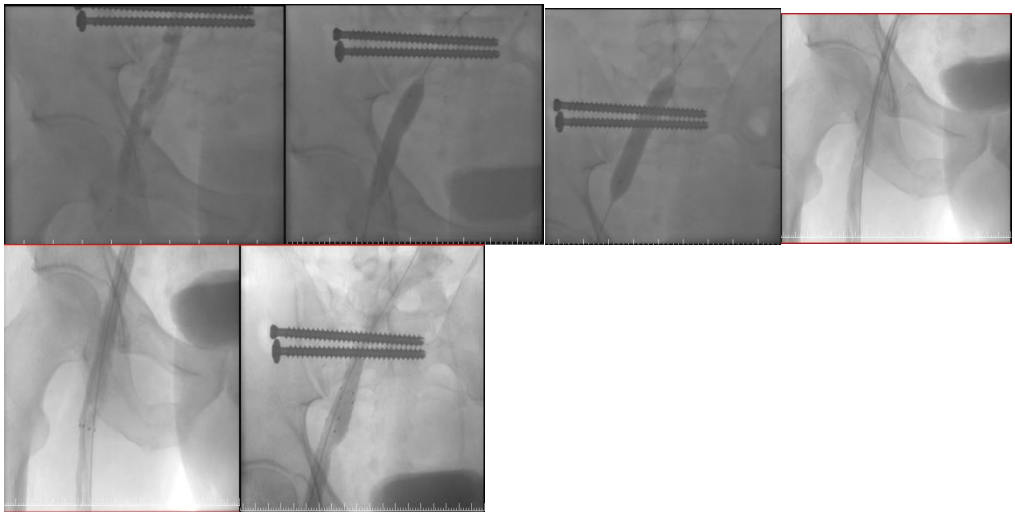

Fig. 5: Case 3 of iliac dissection managed by iliac stent.

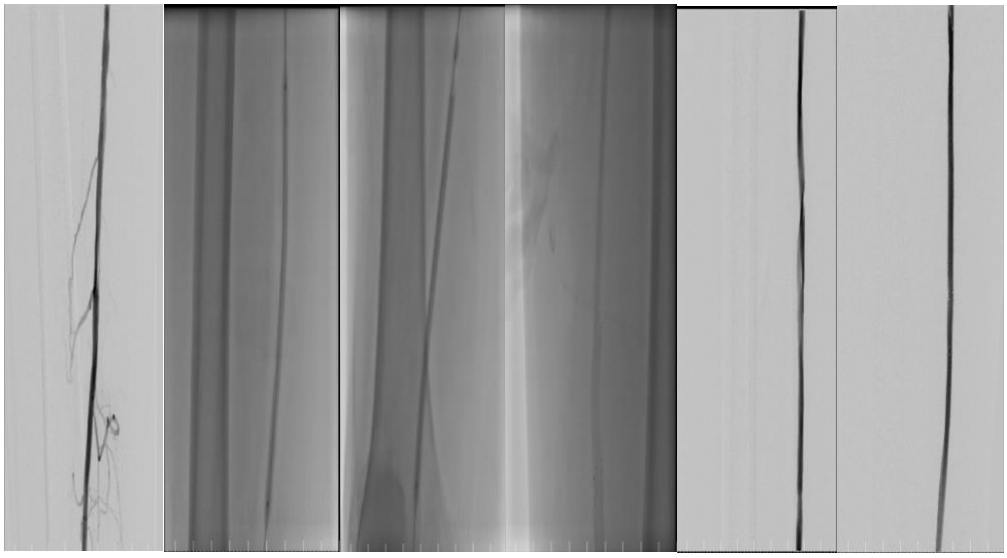

Fig. 6: case of long spiral SFA Dissection managed by stent.

Risk factors	No.	%
DM	49	75.4
Smoking	35	53.8
HTN	47	72.3
IHD	25	38.5
Previous stroke	7	10.8
More than 2	30	44.8

Table 1: Distribution of the studied cases according to risk factors (n = 65)

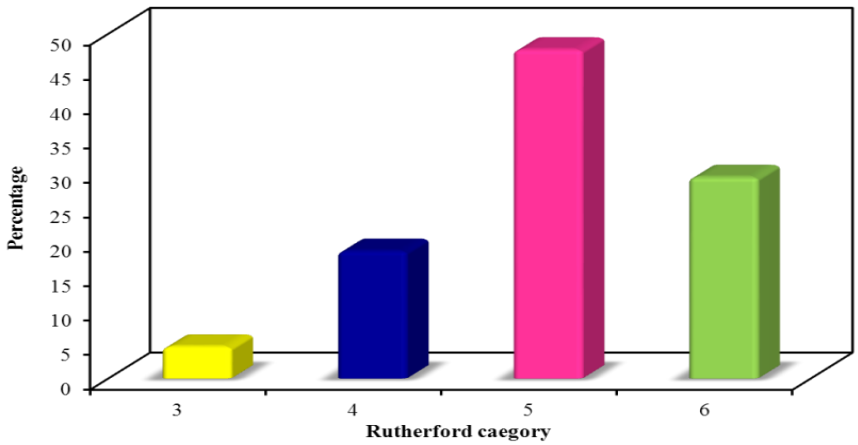

Figure 7: Distribution of the studied cases according to Rutherford category (n = 65)

Site of complication	Lesion morphology		Total
Iliac	Tasc A 0/5	0%	TASC A: 1 (1.5%) TASC B: 13 (20%) TASC C: 22 (33.8%) TASC D: 29 (44.6%)
	Tasc B 1/5	20%	
	Tasc C 3/5	60%	
	Tasc D 1/5	20%	
Femoral	Tasc A 0/28	0%	
	Tasc B 6/28	21.5%	
	Tasc C 13/28	46.5%	
	Tasc D 9/28	32%	
Popliteal	Tasc A 0/16	0%	
	Tasc B 4/16	25%	
	Tasc c 0/16	0%	
	Tasc D 12/16	75%	
Tibials	Tasc A 1/16	6.25%	
	Tasc B 2/16	12.5%	
	Tasc C 6/16	37.5%	
	Tasc D 7/16	43.75%	

Table 2: patients with TASC

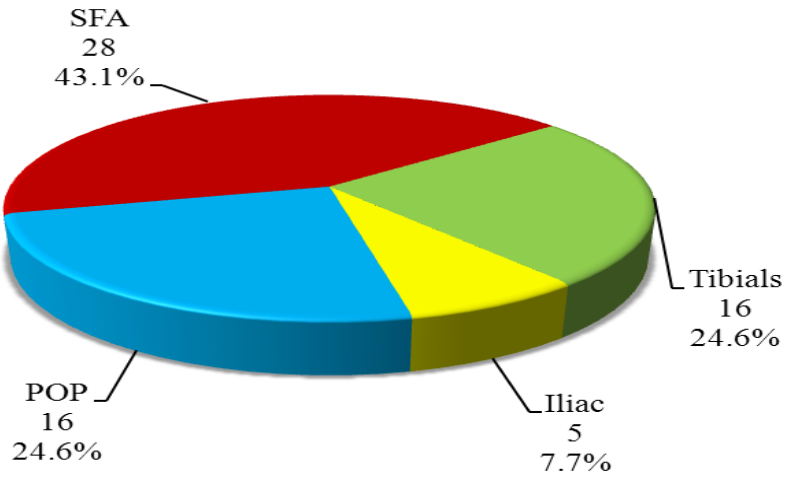

Fig. 8: Distribution of the studied cases according to site of complication (n = 65)

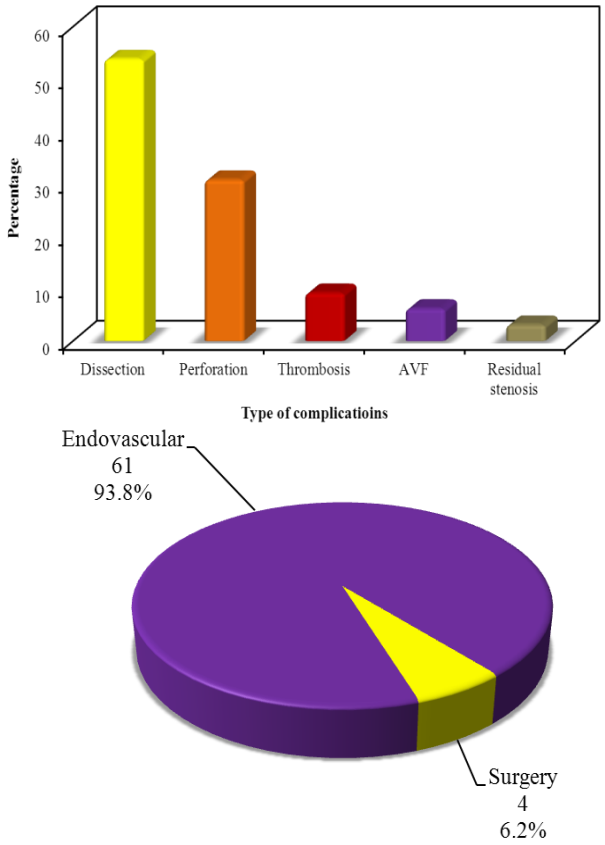

Fig. 9: Distribution of the studied cases according to type of complication and management.

	No.	%
Limb salvage	63	96.9
Mortality	0	0.0

Table 2: Distribution of the studied cases according to limb salvage and mortality (n = 65)

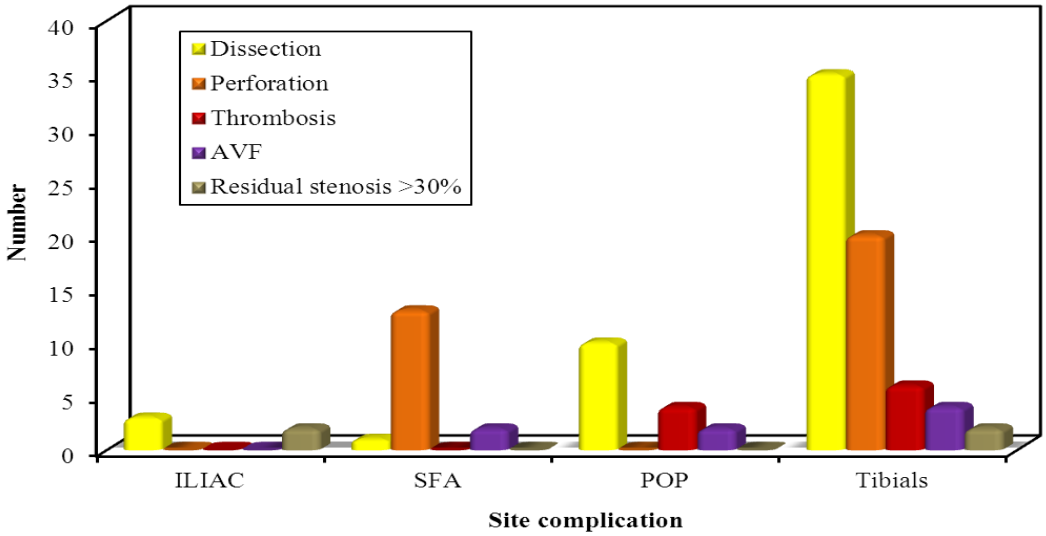

Fig. 10: Relation between type complications and site complication.

Type of complication	Site complication	N	Limb salvage			
			No		Yes	
			No.	%	No.	%
Dissection	ILIAC	3	0	0.0	3	100.0
	SFA	21	0	0.0	21	100.0
	POP	10	0	0.0	10	100.0
	Tibials	1	0	0.0	1	100.0
Perforation	ILIAC	0	0	0.0	0	0.0
	SFA	7	1	14.3	6	85.7
	POP	0	0	0.0	0	0.0
	Tibials	13	0	0.0	13	100.0
Thrombosis and embolization	ILIAC	0	0	0.0	0	0.0
	SFA	2	1	50.0	1	50.0
	POP	4	0	0.0	4	100.0
	Tibials	0	0	0.0	0	0.0
AVF	ILIAC	0	0	0.0	0	0.0
	SFA	0	0	0.0	0	0.0
	POP	2	0	0.0	2	100.0
	Tibials	2	0	0.0	2	100.0
Residual stenosis	ILIAC	2	0	0.0	2	100.0
	SFA	0	0	0.0	0	0.0
	POP	0	0	0.0	0	0.0
	Tibials	0	0	0.0	0	0.0

Table 3: relation between limb salvage and type of complication (% from raw)

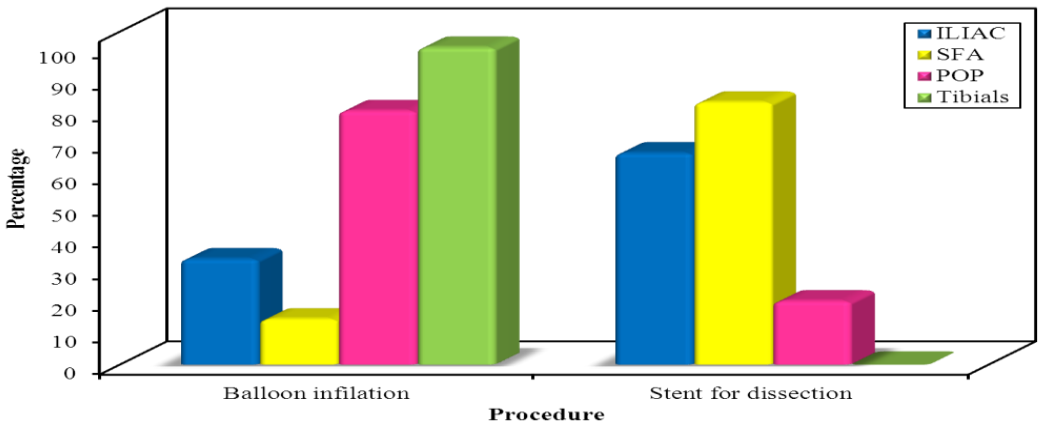

Fig. 11: Relation between Site complication and procedure in dissection type (n= 35)

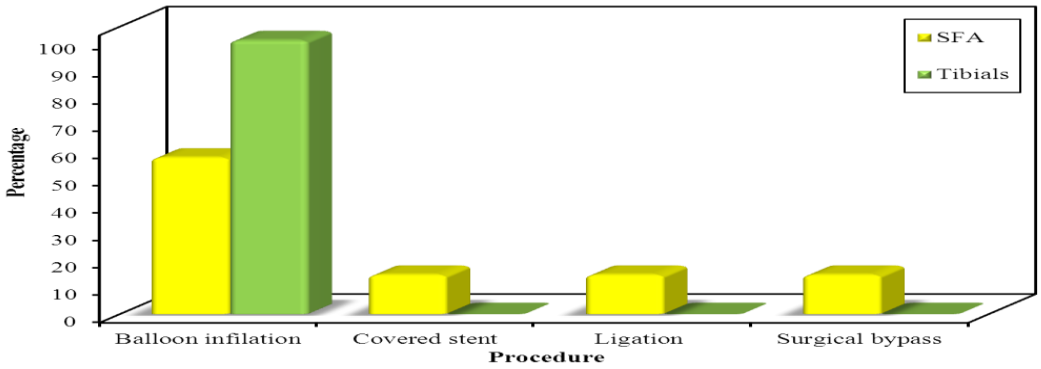

Fig. 12: Relation between Site complication and procedure in perforation type (n= 20)

Procedure	Site complication			
	SFA (n= 2)		**POP (n= 4)**	
	No.	**%**	**No.**	**%**
Thrombolytic theraby	1	50.0	0	0.0
Thrombectomy open	1	50.0	1	25.0
Angioplasty	0	0.0	1	25.0
Suction cath	0	0.0	2	50.0

Table 4: Relation between Site complication and procedure in thrombosis type (n= 6)

Procedure	Site complication			
	POP (n= 2)		**Tibials (n= 2)**	
	No.	**%**	**No.**	**%**
Balloon infilation	2	100.0	2	100.0

Table 5: management of AVFs.

Procedure	ILIAC	
	No.	**%**
Stent	2	100.0

Table 6: relation between Site complication and procedure in Residual stenosis type (n= 2)

outcome	**Technical success**	**Clinical response**	**Haemodynamical success**
	63/65 (96.6%)	60/65 (92.3%)	61/65 (93.8%)

Table 7: study outcome

DISCUSSION

The current study was conducted on 65 patients complaining lower limb ischemia; 39 (60%) males and 26 (40%) females. Patients with age less than 50 years old was 6 (9.2%), from 50 to 60 years old were 20 (30.8%) but patients older than 60 were 39 (60%) with mean age 63.17 ± 9.63 which confirming the data from Gray A. et al 2019.[5] ; mean age was 68.2± 9.1 and 70.9% of patients were men. This confirming that old age and men are more liable to PAD and complications during end vascular interventions. In Fujihara 2017.[6] mean age was 72.6± 9.5 and 66%of them males, 58% diabetic, 88.2% hypertensive, 63% cardiac patients and obesity was 14%.

According to the risk factors and co-morbidities of the patients in the study; 49 (75.4%) were diabetic, 35 (53.8%) were smokers, 47 (72.3%) were hypertensive, 25 (38.5%) with ischemic heart disease, 7 (10.8%) had a previous stroke and 30 patients (44.8%) had more than 2 risk factors and co-morbidities. But In fujihara 2017(6) study: 789 patients with symptomatic SFA lesions 58.4% of patients were diabetic, 88.2% were hypertensive,63.2% with CAD and 52.6% of patients had dyslipidemia. This study has more percentage of diabetic patents and less percentage of hypertensive and CAD patients.

In this study; 3 patients were complaining sever claudication that harm their life style (Rutherford category 3), 12 (18.5%) presented with ischemic rest pain (Rutherford category 4), 31 (47.7%) presented with minor tissue loss (Rutherford category 5), 19 29.2%) presented with major tissue loss (Rutherford category 6) so 95.4% of patients had critical limb ischemia unlike fujihara 2017 and Gray A. 2019 studies . Fujihara 2017.[6]only 35% of patients had CLI. Gray A. 2019(5) 4.6% of patients had CLI. So the current study was conducted on a larger percentage of critical cases.

According to primary lesion morphology the current study has 1.5% of TASC A , 20% of cases had TASC B lesions, 33.8% of patients had TASC C lesions , 44.6% of patients had TASC D lesions and 78.4% of patients were challenging cases TASC C and D. In fujihara 2017.[6]study 46.5% of patients had TASC CD. So this study has more challenging and difficult cases for endovascular intervention.

The critical situations that happened during endovascular intervention were; Dissection 35 (53.8%), Perforation 20 (30.8%), Thrombosis 6 (9.2%), 4 (6.2%) cases with Arteriovenous fistula and 2 (3.1) cases of residual stenosis. Two cases developed more than one type of complications during intervention. In Abd El-mabood et al 2017.[7]; flow limiting dissection was 60%, Thrombosis 56.7%, Residual stenosis 43.3%, perforation 30% of cases and equipment failure in 13%, but elkashef study was conducted on SFA lesions only and for patient with morphological lesion TASC A and B only. In Siracause 2017.[8] 1014 case for femoral artery endovascular intervention developed 45 critical situation; 27(60%) dissection which is near to the current study. 7(15%) access site occlusion. [6] (13.5%) perforation. 7(15.5%) thrombosis. But the current study was conducted on larger number of patients with critical limb ischemia as in Siracause 2017 67% of studied patients complaining intermittent claudications.

Most of cases were managed endovascular 61 (93.8%) but 4(6.2%) cases managed by surgical methods. Unlike hayes et al study 52% of cases that developed complications were managed by endovascular techniques as hayes study was quiet old so there was lack of facilities for endovascular tools.

In this study there were 35 cases of dissection distributed according to site; Iliac 3(8.5%), SFA 21 (60%), POP 10 (28.5%) and tibials one case (2.9%). 20 cases of perforation 13 of them (65%) in tibial arteries and 7 (35%) in tibial arteries. 6 cases of thrombosis; 2 of them (33.3%) in pop artery and 4 cases (66.6%) were in SFA. 4 cases developed AVF; 2 (50%) were in pop artery and 2 (50%) in tibial arteries. 2 cases of residual stenosis were in iliac arteries. Dissection was the most common complication in this study and SFA was the most liable artery for dissection, perforation was the 2nd type of complication and tibial arteries were the most common site for perforation. Abd El-mabood et al 2017.[7]was conduted on SFA: dissection was 60% of cases.

Two cases were gone for above knee amputation; one case of SFA perforation that failed to be managed by endovascular tools and managed by ligation of the femoral artery. The other case was case of SFA thrombosis and the open thrombectomy was failed. And all cases of dissection successfully managed by endovascular.

Dissection was the most common type of complication in this study 35 cases 3 of them (8.5%) were in iliac arteries; 2 cases (66.7%) were managed by stenting and one case (33.3%) was managed by balloon. In SFA 21(60%); 18 (82.7%) of SFA dissections were managed by stenting and 3(14.3%) were managed by balloon inflation but in fujihara et al 2017.[6] 555 cases from 748 (74.1%) needed stenting and 193 25.8% were managed by balloon. The higher rates of stenting in the current study due to the higher rates of lesion of Tasc C&D than fujihara study. Pop dissections were 10 (28.5%) cases; 8 (80%) were managed by balloon inflation and 2 cases (20%) were managed by stenting, Elens M. et al 2018(9): 43 patient with pop CTOs 16 (37.2%) managed by angioplasty only and 27 (62.8%) needed angioplasty and stenting with no significant difference between them and their 1 year patency. Only one case developed critical flow limiting dissection in tibial arteries and managed by long inflation balloon. But in Gray A. 2019; 396 dissections, 213 of them received tack implant which didn't used in the current study and single case received bailout stent.

As regard perforation in the current study; 20 cases of perforation 3 of them were in tibials and 7 cases were in SFA.

In SFA cases; 4 (57.1%) managed by balloon inflation, one case (14.1%) was managed by covered stent, one case (14.1%) was managed by surgical bypass after failure of endovascular management and one case (14.1%) failed to be managed by endovascular tools and managed by ligation of the artery for life saving. In tibials all cases (100%) of perforation were successfully managed by long inflation balloon. Which is better than results of Hayes et al.[10], 52 patient had suffered a perforation. The mortality rate was zero, no patients required surgery at the site of perforation, and 27(52%) procedures were completed successfully despite the complication. However, of the remaining 25(48%) patients in whom the procedure was aborted, 6 underwent bypass surgery and 2(3.8%) ultimately required major amputation. Our study had less percentage of cases that referred for surgery and 1(20%) case from all perforations had went for major amputation which is like hayes study.

Embolization and thrombosis as critical situation, 6 cases were developed distal embolization or thrombosis; 4 of them were in pop artery and 2 cases were in SFA. Cases of SFA thrombosis; one case was managed by thrombolytic therapy and one case was managed by surgical thrombectomy 50% for each method. Cases of pop thrombosis were managed by; surgical thrombectomy one case 25%, angioplasty one case 25% and 2 cases were managed by suction catheter. over all from 6 case 4 cases (75%) were managed endovasculary and 2 cases (25%) in comparison to Ochoa C. et al 2017.[11] in 10875 procedures 17.3% of them developed distal embolization 68% of them needed intervention 84.8% of them were managed endovascular and 16.2% surgical. In Katsanos K. 2014.[12] acute thrombosis was 1% of all cases and managed by thrombolysis, thrombectomy and bypass.

AVF that occurred during interventions is not a common complication. In the current study: 2 cases were developed between pop artery and vein and 2 cases in tibials all cases successfully managed by long standing inflation balloon and the fistulae were closed. No cases needed covered stents nor surgical closure. But in Ananthakrishnan G. 2006[13], 12 patients developed AVFs during lower limb angioplasty. 1 SFA and 11 tibials AVF. 3 cases were managed successfully by balloon inflation alone, 5 cases were managed by coils, 1 case failed angioplasty ang was gone for surgical bypass, and the other 3 cases were developed other dissection and managed by balloon angioplasty and stenting by bare stents.

The primary outcome parameters were; technical success was reported in 63 (96.9%) of cases by presence of antegrade blood flow through the lesion at the end of the procedure. Clinical response in 60 (92.3%) less than technical success as there were two cases of persistent rest pain post procedure and one case of persistant ischemic ulcer and haemodynamic success in 61 cases (93.8%). And 4 (6.1%) managed surgical. Abd El-mabood et al 2017 had technical success rate 90.1% and clinical response was 83%. The current study had better results as Abd El-mabood et al 2017 was conducted on SFA only and had a larger number of cases that managed surgical with lower success rates than cases that managed by endovascular techniques. In Ananthakrishnan G. 2006 technicclinical success was 100% but clinical response was 91.2%.

CONCLUSION

Although endovascular intervention are minimally invasive procedures which became the first line of treatment in infrainguinal PAD and carry less risk of complications than surgery, there are numerous critical situations during the intervention that could complicate the procedure or abort it.

Most of the critical situations could be managed successfully with endovascular procedures without abort the intervention. Surgery remains an option for managing the endovascular complications that couldn't be managed by endvascular techniques.

Challenging cases with difficult morphological lesions (TASC CD) carry higher risk of complications which could be managed by endovascular procedures in most cases.

The usage of stents could vanish dissections especially in cases of long spiral dissection, persistent filling defects and total occlusion flabs. Small linear dissections, tibials and most of pop dissections could be managed by long standing balloon inflation without stenting.

Most of artery perforations and even avfs could be managed by long balloon inflation without the need for covered stents nor surgery. Recent distal embolization could be managed by suction with syringe and multipurpose catheter.

Cases with failed endovascular bailout techniques and then managed by surgery carry higher risk of limb loss than cases that were managed by endovascular procedures. Technical success isn't the end point of vascular surgery role in cases of limb ischemia as clinical response and limb salvage have more importance.

Endovascular interventions in lower limb ischemia have daily innovations in tools and techniques that carry more challenges and need further more knowledge and training.

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