Comparative Study Between Territorial and Non-Territorial Infrapopliteal Angioplasty

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ABSTRACT

This is case series include a prospective comparative study of 23 patients presented to vascular surgery department in KasrEl-Aini with critical lower limb ischemia for whom PTA was done between February 2012 to December 2012. The patients were divided into two groups (territorial and non territorial .The aim of the study is to assess the effect of territorial and non territorial infrapopliteal angioplasty on ulcer healing in patients complaining from critical limb ischemia .The age varies was 50-70 with mean ±SD (60±4) in territorial group and was 45-74 with mean ±SD (58.8±8.7) in the non-territorial group. The clinical diagnosis and anatomical characteristics of the lesions in theterritorial and non-territorial group were recorded. The Procedural data, patency at 3, 6 months, and limb salvage at 3, 6 months was recorded. Therewas no statistically significantly difference between the two groups. The mortality rate was two cases, one in the first 3month follow up and the other was in the 6 month follow up. Both were in the territorial group. In the territorial group, there were two cases of below knee amputation(BKA),and one case of above knee amputation(AKA)(23%). In the non territorial group there were two case of major amputation, one AKA,and one BKA (20%).

Key words: *Angioplasty-angiosome-infrapopliteal*

INTRODUCTION

Peripheral arterial disease (PAD) is not uncommon disease .It is presented world wide. Peripheral artery occlusive disease is estimated to occur in 3% of people aged 40-59 years and in 20% of people over 70 years[1].

Critical limb ischemia (CLI) is a severe form of PAD, which may, or may not be preceded by intermittent claudication. It is more common with increasing age. It is definitely related to smoking, diabetes mellitus, hypertension, dyslipidemia, hyperviscosity, hypercoagulable states, and hyperhomocysteinemia. It is associated with chronic renal insufficiency.The TASC II guidelines states that 15% of diabetic patients will develop a foot ulcer during their lifetime; among these, up to 24% of subjects will require an amputation however, 85% of amputations can be prevented by early detection and appropriate treatment[2,3]

Although adominant part of the diabetic ulcers are neuropathic, various studies have shown thatn early half have an ischemic component. In the era of development of minimally invasive strategies and endovascular therapy allows better results, shorter hospital stay in comparable to other modalities like surgery[4,5]

The angiosome principle provides useful informationon vascular anatomy of the foot and ankle and the angiosome mapping may be beneficial when treating diabetic neuroischemic foot wounds associated with aggressive atherosclerotic disease and poor collateral circulation. Six angiosomes of the foot and ankle are supplied by the three main arteries. The posterior tibial artery (PTA) supplies the plantar aspect of the toes, the web spaces between the toes, the sole of the foot, and the inside of the heel. Three main branches of the PTA supply distinct portions of the sole: the calcaneal branch to the heel, the medial plantar artery to the instep, and the lateral plantar artery to the lateral midfoot and the forefoot. The anterior tibial artery (ATA) becomes the dorsalis pedis artery that supplies the dorsum of the foot. The peroneal (PA) supplies the lateral border of the ankle and the outside of the heel. Two branches of the PA supply the anterolateral part of the ankle and the hind foot: the anterior perforating branch to the anterolateral part of the upper ankle and the calcaneal branch to the plantar aspect of the heel (figure 1)[6.7]

PATIENTS & METHODS

This case series include a prospective comparative study of 23 patients presented to vascular surgery department in Kasr El-Aini with critical limb ischemia for whom PTA was done between February 2012 to December 2012.

The aim of the study is to assess the effect of territorial and non territorial infrapopliteal angioplasty on ulcer healing in patients complaining from critical limb ischemia .

The procedure, possible complications, benefits, risks and other alternative interventions were all explained to all patients and an informed consentwas taken.

Methodology:

Data from files include:

1. Clinicaldata: history, examination, age, gender and major risk factors.
2. Preprocedure investigations: routine labs, duplex scans.
3. Selectioncriteriaforourstudy: Patients with critical limb ischemia due to infrapopliteal arterial occlusive disease with or without proximal occlusions.

Loading dose of Clopidogrel 300mg was given the night before the procedure. *Local anesthesia is given: lidocaine 2% 5cc.* Ipsilateral antegrade common femoral artery approach was used in all cases. Intra-arterial 1000 IU heparin is given immediately after insertion of the sheath and if the procedure is longer than one hour another ampoule was given. The procedure starts with angiography to outline the severity and the distribution of the lesions to plan the intervention. Infrapopliteal lesions were classified according to the TASC classification of the infrapopliteal disease. The policy was to revascularize more than one tibial vessel if possible in casesof gangrene, severe infection or tissue loss. If not possible we try to revascularize the territorialvessel if failed we revascularize any vessel giving straight line flow to the foot (non territorial).

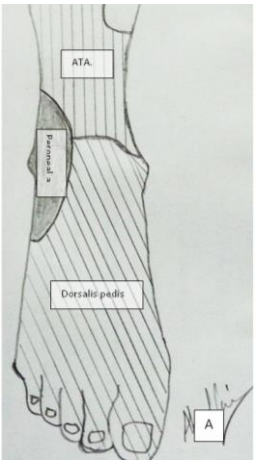

Fig. 1a: Shows anterior tibial artery (ATA) angiosome with continuation to Dorsalis pedis artery angiosome and peroneal artery angiosome (PA).

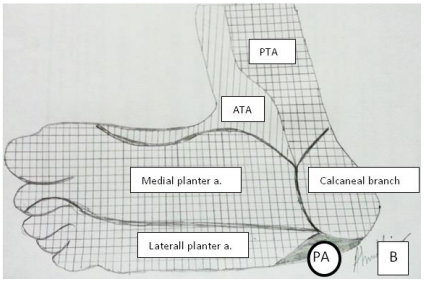

Fig. 1b: Shows Posterior tibial artery (PTA) angiosome (medial planter, lateral planter, calcaneal branch),peroneal artery angiosome (PA)

Fig. 2a: Posterior tibial artery proximal attenuation

Fig. 2b: Crossing the lesion with 0.014 " PT2 wire balloon dilatation (3mm X 120mm balloon**.**

Fig. 2c: Posterior tibial artery post balloon dilatation

Fig. 3a: Anterior tibial artery (ATA) occlusion.

Fig. 3b: Crossing the lesion in ATA by 0.014" PT2 wire balloon dilatation 3mm X 120mm balloon.

Fig. 3c: Anterior tibial artery balloon dilatation

Fig. 3d: Anterior tibial post balloon dilatation

Fig. 3e: Anterior tibial artery entering the foot

Long tibial occlusions were crossed by wire 0.018" or 0.014" (*transluminal) , or subintimal* and rarely we used 0.035 " wire. Low profile balloons (diameter 1.5-3mm) were used with lengths slightly larger the target lesion. Fig (2,3). The balloons were inflated at 8-14 ATM (according to the manufacturer recommendation). Multiple inflations were practiced with to talinflation time ranging from1-3 minutes. 100-200 microgram of intra-arterial Nitroglycerine was routinely injected before the completion angiogram. A check angiogram was performed with the wirein place for access. Redilatationwas done in the following situations: residual stenosis ≥30%, dissection, elasticrecoil**.** Inthisstudy, no stents were used in any of the cases**. Technical success** is defined as presence of less than 30% residual stenosis measured at the narrowest point of the vascular lumen**. Clinical success** is defined as **r**esolutionofpain, regaining of distal pulse, healing ofulcers. Short-termfollow upwas done by monitoring patency by feeling pulsation, and duplex examination. Limb salvage is defined as no major amputation and patient resuming functional autonomy**.** After the procedure is finished**,** sheath was removed immediately after the procedure followed by digital compression for 10-20 minutes and delayed mobilization for 12-24 hours that if 5000 IU heparin were given. If 7000-10000 IU heparin were given wedelay sheath removal until APTT returns to normal. Most patients were discharged on the second day. On discharge all patients were given acetyl salicylic acid 75-150 mg/day for life, Clopidogrel 75 mg/day for at least 3 months. Statins in case of dyslipidemia as proved by the preoperative laboratory investigation**.**

RESULTS

(A) Demographic Data:

The age varies was 50-70 with mean ±SD (60±4) in territorial group and was 45-74 with mean ±SD (58.8±8.7) in the non-territorial group. All the patients either the territorial group or the non-territorial group were diabetics and smokers and dyslipidemic. Most of the territorial, andnon-territorial groups were hypertensive 92.3%, and 90% respectively. Regarding the IHD the prevalence was 76.0%, and 80% in the territorial, and non-territorial group respectively. Table 1

Table (1): Description of the demographic data and risk factors

	Territorial revascularization (n=13)	**Non Territorial revascularization (n=10)**
Age (years)	50-70 (60±4)	45-74 (58.8±8.7)
Diabetes	13 (100.0%)	10 (100.0%)
HTN	12 (92.3%)	9 (90.0%)
Smoker	13 (100.0%)	10 (100.0%)
Dyslipidemia	13 (100.0%)	10 (100.0%)
IHD	10 (76.9%)	8 (80.0%)

The clinical diagnosis and anatomical characteristics of the lesions in the territorial group are shown in table (2). The clinical diagnosis and anatomical characteristics of the lesions in the non-territorial group are shown in table (3). The Procedural data, patency at 3, 6 months, and limb salvage at 3, 6 months was recorded (table 6).

Concerning the territorial revascularization, The 3 month patency for both dorsal and heel lesions was 100%. The 6 month Patency for both dorsal and heel lesions was 81.8% and 50% respectively. The 6 months limb salvage rate for dorsal and heel lesions was 90.9% and 50% respectively. (Table 6). The Limb salvage rate according to TASC classification is shown in table (4), figure(2).

Concerning the non territorial revascularization, the 3 month patency for both dorsal and heel lesions was 100% for both. The 3 months limb salvage rate for both dorsal and heel lesions was 66.7% and 75% respectively. The 6 month patency for both dorsal and heel lesions was 66.6% and 75% respectively. And the 6 months limb salvage rate for dorsal and heel lesions was 50% and 75% respectively.(Table 6) Limb salvage rate according to TASC classification is shown in table (5), figure (3).

Table (2): Relationship between clinical diagnosis of the lesion and occluded tibial vessels in territorial group (n=13)

	ATA occlusion	**PTA occlusion**	**Peroneal occlusion**
Dorsal ulcer (n=6)	6	6	3
Dorsal gangrene (n=5)	5	5	2
Heel ulcer (n=2)	2	2	2

**Territorial revascularization means ATA revascularization in dorsal lesions and PTA revascularization in heel lesions.

Table (3): Relationship between clinical diagnosis of the lesion and occluded tibial vessels in nonterritorial group (n=10)

	ATA occlusion	**PTA occlusion**	**Peroneal occlusion**
Dorsal ulcer (n=3)	3	3	3
Dorsal gangrene (n=3)	3	3	2
Heel ulcer (n=4)	4	4	4

**Non-territorial revascularization means PTA revascularization in dorsal lesions and ATA revascularization in heel lesions.

Table 4: Limb salvage rate in the territorial group according to TASC classification

	Limb salvage 3 months	**Limb salvage 6 months**	**P value**
TASC B	10 (76.9%)	10 (91.9%)	0.6NS
TASC C	3 (23.1%)	1 (9.1%)	NS

Table 5: Limb salvage rate in the non territorial group according to TASC classification

	Limb salvage 3 months	**Limb salvage 6 months**	***p*-value**
TASC B	5 (71.4%)	5 (83.3 %)	1.0NS
TASC C	2 (28.6%)	1 (16.7%)	NS

Table (6): comparison between procedural data, patency and limb salvage in both territorial and non-territorial groups

	3 months patency	**6 months patency**	**3 months limb salvage**	**6 months limb salvage**
Dorsal lesions Territorial revascularization	11(100.0%)	9(81.8%)	11(100.0%)	10(90.9%)
Dorsal lesions **Non** Territorial revascularization	6(100.0%)	4 (66.7%)	4 (66.7%)	3 (50.0%)
P value	1.0 NS	0.6 NS	0.1 NS	0.1 NS
heel lesions Territorial revascularization	2(100.0%)	1(50.0%)	2(100.0%)	1 (50.0%)
heel lesions **Non** territorial revascularization	4(100.0%)	3(75.0%)	3 (75.0%)	3 (75.0%)
***p*-value**	1.0 NS	1.0 NS	1.0 NS	1.0 NS
All the territorial group	13(100%)	10(76.9%)	13(100%)	11(84.6%)
All the **Non** territorial group	10(100%)	7(70%)	7(70%)	6(60%)

Table 7: Limb salvage rate in the territorial group versus the revascularized arteries

	Limb salvage 3 months	**Limb salvage 6 months**	***p*-value**
Angioplasty to ATA only n=2	2	1	0.5 NS
Angioplasty to ATA and peroneal n=9	9	9	1.0 NS
Angioplasty to PTA only n=0	0	0	1.0 NS
Angioplasty to PTA and peroneal n=2	2	1	0.5 NS

Table 8: Limb salvage rate in the non territorial group versus the revascularized arteries

	Limb salvage 3 months	**Limb salvage 6 months**	**P value**
Angioplasty to ATA only n=1	1	1	1.0 NS
Angioplasty to ATA and peroneal n=2	2	2	1.0 NS
Angioplasty to PTA only n=2	2	1	0.5 NS
Angioplasty to PTA and peroneal n=2	2	2	1.0 NS

Concerning the complications, there were no access complications. The mortality rate was two cases, one in the first 3month follow up and the other was in the 6 month follow up. Both were in the territorial group. In the territorial group, there were two cases of below knee amputation (BKA), and one case of above knee amputation (AKA) (23%). In the non territorial group there were two case of major amputation, one AKA, and one BKA (20%). In the whole study, the major amputation were 3 cases of below knee amputation (BKA) in the 3 month follow up, and 2 cases of BKA in the 6 month follow up.

DISCUSSION

The TASCII guidelines states that 15% of diabetic patients will develop a foot ulcer during their lifetime; among these, up to 24% of subjects will require an amputation however, 85% of amputations can be prevented by early detection and appropriate treatment.[2] Although adominant part of the diabetic ulcersare neuropathic, nearly half have an ischemic component. Better results can be achieve by endovascular therapy[6]. Primary endovascular strategies provide low complication rates and limb salvage rate comparable with surgery. Endovascular strategiesseem to have the advantage of enabling simultaneous multiple vessels recanalization and result in shorter hospital stays and health expenditure[4,5]

As regard ulcer healing **Södeström and her colleagues in 2013**, collected 250 consecutive legs with diabetic foot ulcer. In 226 patients who did infrapopliteal endovascular revascularization results were that foot ulcer healing is better for those who didterritorial revascularization than those who didnon territorial revascularization 72% vs 45% respectively ($p<0.001$). These results may be due to choke vessels in diabetics tend to be compromised in non territorial revascularization. Also they reported that in the non territorial revascularization group, the older age made the artery perfusing the ulcer exhibit severe occlusion and calcificationas the age is a well-known risk factor in arterial occlusive disease[8]

Kabra *et al.* analyzed 64 patients with single crural vessel run off to the foot presented with critical limb ischemia from January 2007 to September 2008. In the previous study territorial group number 39 (61%) and non-territorial group number 25 (39%). Results regarding ulcer healingin 1,3,6 months for territorial revascularization group versus non territorial revascularization group were 7.9%vs 5%, 57.6%vs. 12.5% and 96.4%vs 83.3%, respectively. These statistically significant results may be due to absence of arterioarterial connections in the non-territorialre vascularization group[9].

In our study the ulcer healing in the territorial and non-territorial revascularization group at 3 and 6 months were 100% versus 70% and 84.6% versus 60% respectively with statistically non-significant difference between the two groups. The healing rate in the non-territorial group at 3 and 6 months can be due to following: first, intact pedal arch after completion of the procedure.

Second, adding revascularization of the peroneal allow interconnections with the dorsalis pedis and lateral planter artery for perfusion via its anterior perforating branch or the calcaneal branch. These results didn't show that territorial revascularization supersedes non territorial revascularization.

Regarding the amputation rate **Kabra et al**. stated that 16% amputationrate in the territorialre vascularization group while 25% among those who did non territorialre vascularization was due to application of the angiosome concept of revascularizing the source artery result in lowering amputationrate among territorial revascularization group.[9]

Neville *et al.* reported 9% amputation rate among territorialrevascularization group while 38% among non territorial revascularization group they attributed this to the overwhelming infection[10]. Most of the complications we have in our study were due to spreading of infection even with successful revascularization. **Lida *et al.*** reported amputation rate among territorial revascularization group 15% and 26% in the non territorial revascularization group. High number of major amputations in the territorial group was also attributed to severe infection as evident by high level of CRP among those who did non territorial revascularization. Another cause in Lida et al study is the poor glycemic control periprocedure rather than to the presence of diabetes during the post-operative period that lead to decrease immune response and delay wound healing as well as progression of microangiopathy.[11] In our study regarding the amputation it was 23% in the territorial group and 20% in the non territorial group. In the territorial group this result is attributed to delayed presentation and extensive infection of 3 lesions even with successful endovascular reconstruction. But in non territorial group the amputation is noted in cases who did one vessel revascularization other than peroneal. It is of great value and importance to study the micro-circulation of the tissue around the wound or the gangrenous region when performing endovascular therapy and targeting aspecific vessel for revascularization. At any time angiosomal concept should not supersede good surgical judgment, and patients' safety. Angiosomal concept was applied by several studies either angioplasty alone, surgery (bypass) alone, or both them (hybride). Most of studies were retrospective. Only Kabra and his colleagues had prospective study[9]. However small number of cases as in our study.Although our results may not prefer territorial over non territorial, thismay be attributed to small number of cases,

Conclusions

The comparison between territorial and non territorial was no statistically significant in our study. There are some difficulties in fulfilling angiosome concept like technical difficulties, patient variability in disease severity, effect of collaterals, and spreading of infection. Further studies are needed with larger number of patient especially with every day evolution of endovascular therapy equipment.

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