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Angiología

Technic Note

Utility of pedal acceleration time: a novel predictor of limb salvage

Utilidad del tiempo de aceleración pedal, un nuevo predictor de rescate de extremidades

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INTRODUCTION

The global prevalence of peripheral arterial disease (PAD) ranges from 3 % up to 12 %. The vast majority of the population affected by this disease lives in low to medium-resource regions (1). The diagnostic suspicion of PAD is based on symptoms, physical findings, and the patient's past medical history. Non-invasive arterial studies (plethysmography, segmental pressures, and Doppler waves) are a fundamental pillar and the standard method to evaluate arterial perfusion of the lower limbs in any vascular practice (2); however, they have some limitations, especially in diabetics, the elderly, and patients with chronic kidney disease (CKD) due to the calcification of the arterial media, which can lead to overestimating the ankle-brachial index (ABI) result (3). Additionally, the need for specialized equipment to perform these tests and their associated costs lead to poor availability. For this reason, recent studies have described pedal acceleration time (PAT) performed via Doppler ultrasonography as a non-invasive diagnostic alternative (4).

DEVELOPMENT

Pedal acceleration time (PAT)

Acceleration time is defined as the time from the start of the systolic rise to its maximum acceleration point in the Doppler arterial flow curve (Fig. 1). Based on this and the concept of foot angiosomes, Sommerset et al. correlated the pedal acceleration time (PAT) of the lateral plantar artery with the ABI and symptoms in non-diabetic patients, finding a statistically significant linear relationship (5).

Based on the above, the following classification for PAT (Table I) was defined. While several studies have validated the relationship between ABI and PAT, their results do not match the equivalencies suggested by Sommerset et al. (4-6). A study conducted in Medellín, Colombia, suggests the following distribution (4):

- PAT < 120 ms: Normal ABI.
- PAT from 120 to 160 ms: ABI from 0.5 up to 0.9.
- PAT > 160 ms: ABI < 0.5.

A prospective study published in 2021, which evaluated PAT pre- and post-revascularization in patients with

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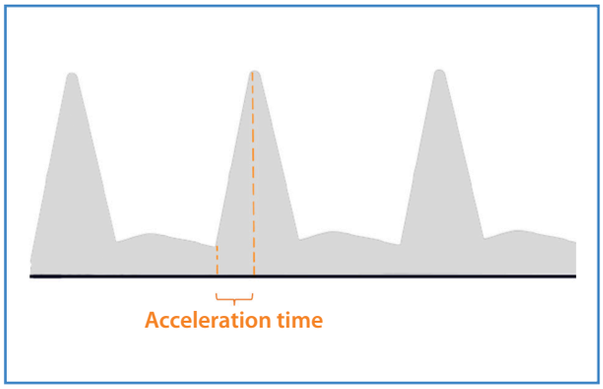

Figure 1. *Spectral Doppler. The limits for measuring PAT are shown.*

arterial stiffness, concluded that values < 180 ms are associated with better outcomes (2). This was validated by other studies showing a reduction in amputations with improved post-intervention PAT; however, this only occurred after reaching Category I values, depending on the relationship with the degree of tissue loss in Category II post-treatment (7).

The implementation of PAT in perioperative evaluation aims to achieve 4 key purposes:

1. Identify the extent and distribution of the disease, as well as the quality of potential conduit grafts.
2. Pinpoint potential access sites.
3. Quantify the calcium load in the feet.
4. Formulate an initial care plan (8,9).

PAT protocol

Anatomy

Foot irrigation is provided by the plantar and dorsal systems. The plantar arch is derived from the posterior tibial artery, which passes behind the internal malleolus; on the sole, it bifurcates into the medial and lateral plantar arteries. The lateral plantar artery gives rise to the deep plantar and metatarsal plantar arteries (5). The dorsal arch is derived from the pedial artery, the terminal branch of the anterior tibial artery (10,11), which gives rise to the arcuate artery and the dorsal metatarsal artery (Fig. 2) (5). The peroneal artery communicates with the posterior tibial artery via the posterior communicating artery and the lateral branch of the calcaneal artery, with the anterior tibial artery via the anterior communicating artery (12), providing an important bypass in PAD.

Technique

The protocol describes measuring PAT using a 7-12 MHz linear transducer for spectral Doppler evaluation, velocity, and permeability at 4 sites: the arcuate artery, medial plantar artery, lateral plantar artery, and deep plantar artery (13).

During spectral measurement, the color gain must be increased so that the vessel is fully filled. Measurements should be taken at the center of the artery. The measurement angle must be ≤ 60°. The peak systolic velocity should represent ¾ of the maximum adjusted elocity (13).

It is recommended to perform 20 supervised evaluations to achieve an adequate learning curve (13).

CONCLUSIONS

PAT appears to be a promising new diagnostic and prognostic method, especially in patients with arterial stiffness. However, further studies are required to validate its utility in different scenarios, as it becomes operator-dependent (13). Nonetheless, a shorter pedal acceleration time is associated with a better prognosis for the extremity.

Table I. Classification proposed by Sommerset et al. (5)

Category	I	II	III	IV
Compromise	No ischemia	Mild ischemia	Moderate ischemia	Severe ischemia
Symptoms	Asymptomatic	Claudication > 2 blocks	Claudication < 2 blocks	Chronic ischemia of the limb (tissue loss, resting pain)
PAT	20-120 ms	121-180 ms	181-224 ms	> 225 ms
ABI	1.3-0.90	0.89-0.69	0.68-0.50	0.49-0.00

PAT: pedal acceleration time; ABI: ankle-brachial index.

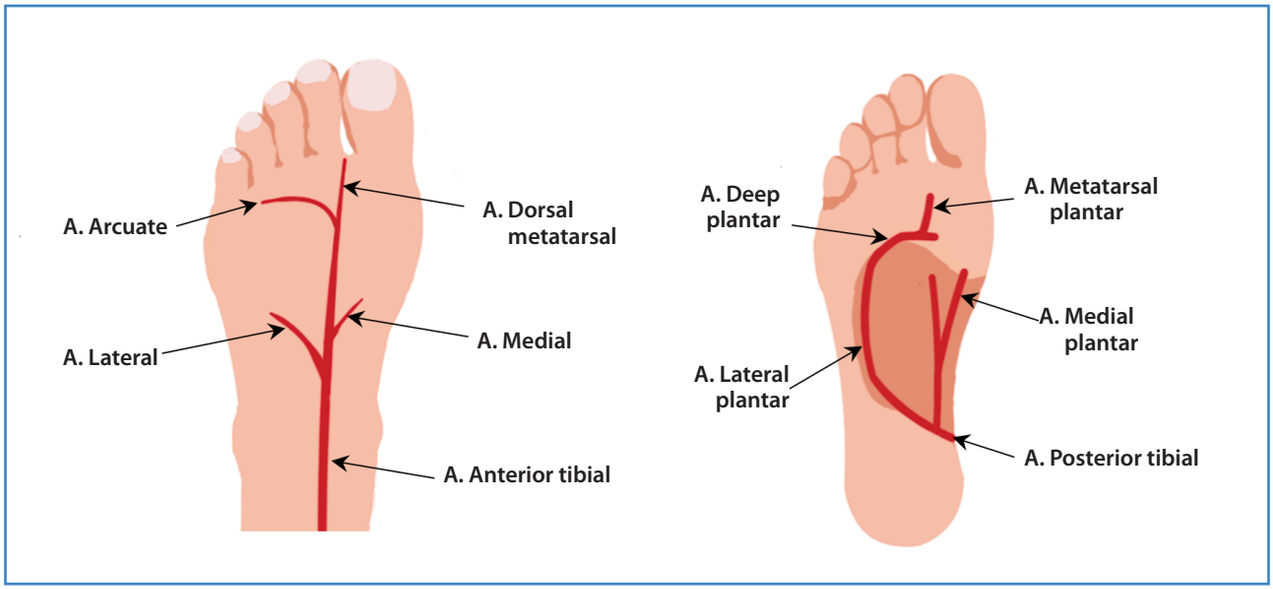

Figure 2. *Arterial anatomy of the foot. Left: dorsal circulation. Right: plantar circulation.*

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