Eur J Vasc Endovasc Surg (2024) 67, 1027–1030

EDUTORIAL

Guidewire Selection and Techniques in Peripheral Arterial Interventions

Successful endovascular revascularisation strongly depends on efficient lesion crossing for which a large variety of guidewires (in combination with a variety of catheters or balloons) is available. Hence, knowledge on guidewire types and their characteristics is key for accurate guidewire selection and technique. However, no standardisation of guidewire selection for peripheral arterial disease (PAD) is available, and there is high physician dependent variation in lesion crossing technique, complicating structured education and training. This edutorial provides an overview of guidewire types, properties, applications, and techniques to guide interventionists in optimal guidewire selection and to provide a backbone for endovascular training.

HISTORICAL PERSPECTIVE

Since 2000, several papers on treatment algorithms, wire selection, and wire techniques for chronic total occlusions (CTOs) have been published.[1–4] Most techniques have been based on antegrade lesion crossing with a regular workhorse guidewire and, if not successful, convert to a retrograde crossing.[5] This bidirectional approach will mostly lead to successful crossing. Nowadays, several new specialty guidewires have been developed to facilitate crossing of occlusions in an antegrade manner.

GUIDEWIRES

To select the appropriate guidewire, the lesion and guidewire characteristics have to be studied carefully. Step one is to understand the different components of a guidewire. These consist of core material (stainless steel, nitinol, or hybrid), core diameter (e.g., 0.014" *vs.* 0.035", with larger diameter providing more support), core taper (longer outer coils providing more trackability, and shorter more support), coating (hydrophilic *vs.* hydrophobic), and the tip (with various tip loads). Guidewires can be divided into two groups: workhorse guidewires with a nitinol, steel or hybrid (steel and nitinol) core and a high lubricity (polymer with hydrophilic) coating; and CTO guidewires with a stainless steel supportive core and hydrophobic coating with less lubricity. Workhorse guidewires are commonly used to navigate through stenotic lesions but also to cross occlusions by using the taper as a loop, while CTO guidewires are specifically developed to cross occlusive lesions since these provide more tactile feedback and have different tip loads to penetrate moderate or heavily calcified lesions (Table 1).

https://doi.org/10.1016/j.ejvs.2024.01.015

In Table 1, brands with only 0.035" platforms and no option for 0.014" platform have been excluded.

ANATOMICAL LOCATION

Guidewire selection used to be location dependent. Aorto-iliac lesions were mostly approached with 0.035", femoropopliteal lesions with 0.035" or 0.018", and below the knee lesions with 0.018" or 0.014" guidewires. With the increasing use of specialty guidewires, the lesion type has become more important than the lesion location. Therefore, the 0.018" platform is more frequently used also in more proximal lesions. Nevertheless, for a direct subintimal approach in heavily calcified aorto-iliac or femoropopliteal lesions, the 0.035" platform remains an important and reliable option.[6]

LESION TYPE AND GUIDEWIRE TECHNIQUE

Pre-operative imaging mostly consists of duplex ultrasound (operator dependent) or computed tomography angiography. After evaluating the lesion on pre-operative imaging, lesions should be divided into stenotic or occluded lesions, by length, and by degree of calcification. Scoring the calcification grade of the lesion in patients with PAD has become common practice.[7,8] Subsequently, an intraluminal (e.g., a stenotic lesion with circumferential calcification) or subintimal (long occluded heavily calcified lesion) path to cross the lesion will be chosen.[9,10] To cross a short occlusive lesion ($<$ 10 cm[11,12]), an intraluminal approach may be preferred using a workhorse guidewire without looping or, if calcified, with a CTO guidewire using the drilling technique. The drilling technique uses an angled guidewire tip as a drill by spinning the guidewire bidirectionally and slightly pushing when crossing the lesion facilitated by a torque device for optimal drilling.

The tip load of a CTO guidewire is chosen according to the severity of the calcification. Tip loads of 6 – 18 gram are considered for moderate calcifications, while $>$ 20 gram tips are used in heavily calcified lesions.

In general, lesion crossing is achieved by a functional interaction between a guidewire and a support catheter or angioplasty balloon, which should be slender to be able to follow the guidewire through the lesion. Increasing support, tip load, and pushability is achieved by continuously bringing the catheter close to the tip of the guidewire. Do not forget to use a long sheath in a below the knee procedure to improve support for crossing, to reduce contrast dose, and to improve imaging quality. Finally, an angled support catheter with good steering properties is beneficial for guiding and re-entry. By using these techniques, most

Table 1. Overview of different guidewires (0.018" and 0.014") and characteristics in endovascular peripheral arterial interventions

Manufacturer	Workhorse wire Stenotic/fibrotic lesions	CTO wire Calcified lesions	CTO wire Heavily calcified lesions
Asahi*	*Gladius 0.014/0.018* Sliding wire (intraluminal) *Gladius MG 0.014/0.018* Dissecting wire with microgap (subintimal)	*Halberd 0.014/0.018 (12 gram)* Drilling calcified lesion (preshape option) *Gaia PV 18 (7.5 gram)* Drilling lesion intraluminal	*Astato 30 0.018 (30 gram)* *Astato 40 0.014 (40 gram)* Tapered tip Penetrating and drilling calcified lesion
Abbott†	*Command 0.014/0.018 ST* Fibrotic lesion/looping (subintimal) *Command ES 0.014* More supportive variant (subintimal)	*Proceed 220T 0.014 (14 gram)* Preshape drilling calcified lesion *Winn 200T 0.014 (14.3 gram)* Tapered tip/Penetrating calcified lesion	*Connect 250T 0.018 (38.1 gram)* Tapered tip Penetrating calcified lesion
Boston Scientific‡	*V14/V18 ST* Loop/knuckle wire (subintimal)	*Victory 14 (12 gram)* *Victory 18 (12 gram)* penetrating calcified lesion	*Victory 14 (30 gram)* *Victory 18 (30 gram)* Penetrating calcified lesion
Terumo§	*Glidewire Advantage 14/18* Loop/knuckle wire (subintimal)	*Glidewire Advantage Track 14/18* Loop/knuckle wire (subintimal)	*Glidewire Advantage Track 14/18* Loop/knuckle wire (subintimal)
Cook‖	*Roadrunner Uniglide 0.018* *Approach Hydro ST 0.014* Loop/knuckle wire (subintimal)	*Approach CTO 0.014 (12 gram)* Penetrating calcified lesion	*Approach CTO 0.014 (24 gram)* Penetrating calcified lesion

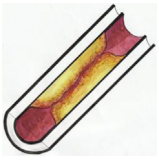
CTO = chronic total occlusion; PV = peripheral vessel; ST = short tapering; ES = extra support.
* Asahi Intecc (Seto-shi, Aichi, Japan).
† Abbott (Chicago, IL, USA).
‡ Boston Scientific (Marlborough, MA, USA).
§ Terumo (Shibuya City, Tokyo, Japan).
‖ Cook (Bloomington, IN, USA).

lesion crossings can be achieved via an antegrade approach using a single guidewire.

In difficult lesions sometimes crossing does not progress and guidewire escalation may be needed. Guidewire escalation is switching from a workhorse to a CTO wire and back especially to cross the calcified areas within the occlusion.

If the lesion is long and calcified, intraluminal crossing may be challenging, and a subintimal approach using a workhorse wire and looping technique may provide an alternative strategy. Sometimes it is difficult to penetrate the proximal cap, and then the CTO wire is helpful in penetrating, followed by switching to a workhorse guidewire to cross the lesion. The reason for this guidewire de-escalation is that CTO wires easily perforate and are difficult to maintain intraluminally especially in long lesions. Guidewire escalation may also be needed for re-entry after

Table 2. Overview of lesion specific crossing techniques in endovascular peripheral arterial interventions

Lesion	Thrombofibrotic lesion	Thrombofibrotic lesion	Calcified lesion	Calcified lesion	Heavily calcified lesion	Heavily calcified lesion
						
Degree of stenosis/ occlusion	Stenotic lesion Occlusion <10 cm	Occlusion >10 cm	Stenotic lesion Occlusion <10 cm	Occlusion >10 cm	Stenotic lesion Occlusion <10 cm	Occlusion >10 cm
Intraluminal/ subintimal	Intraluminal	Intraluminal/ subintimal	Intraluminal	Subintimal	Intraluminal	Subintimal
Wire	Workhorse wire	Intraluminal: Workhorse sliding wire. Subintimal: Workhorse wire with a short taper to loop/knuckle or special dissecting wire with a microgap	CTO wire (6–18 gram) (preshape or shape for drilling)	Workhorse wire with a short taper to loop/ knuckle the wire or special dissecting wire with a microgap	CTO wire (>20 gram) (preshape or shape for drilling)	Workhorse wire with a short taper to loop/knuckle the wire for dissecting or special dissecting wire with a microgap

CTO = chronic total occlusion.

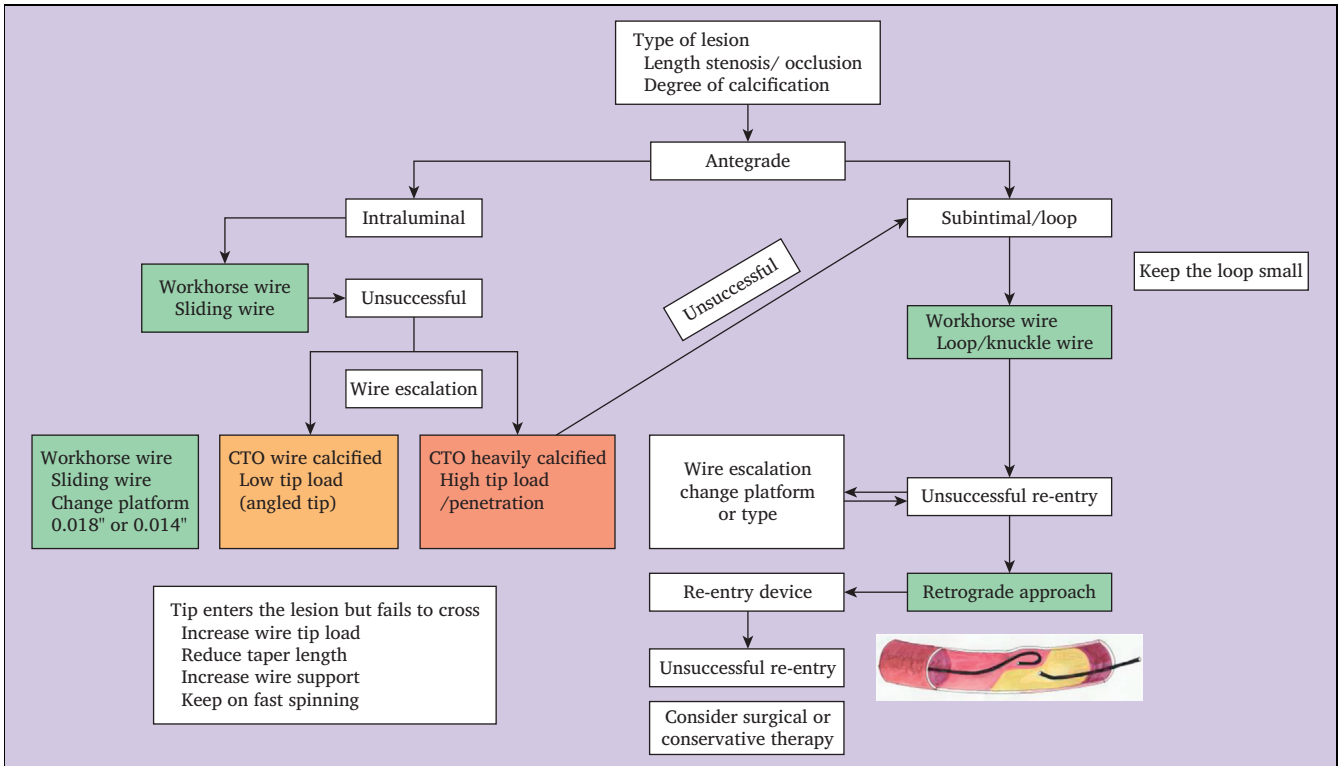


Figure 1. Summary of lesion crossing and guidewire selection in endovascular peripheral arterial interventions. CTO = chronic total occlusion.

a subintimal approach. Table 2 gives an overview of various lesions and suitable techniques.

When starting your practice using the antegrade wire escalation technique, choose your favourite workhorse guidewire, preferably a polymer coated, hydrophilic guidewire with a short nitinol tapering, which will help in keeping the loop small. Durability is an important argument in choosing your workhorse wire. A nitinol core lasts longer. Second, get familiar with two types of CTO wires, with an intermediate tip load (with the option to shape the tip) and a higher tip load with more tapering creating an extra option if crossing is not possible. In the event of re-entry failure, advanced bidirectional techniques[13] or re-entry devices should be available for bailout.[14] In practice, lesion crossing may not always be as easy as described in theory. Therefore, always consider discontinuing a procedure if no progress is being made in order to avoid complications and to prevent excessive radiation exposure to the patient and the endovascular team, and opt for a second attempt at a later stage (Fig. 1).

This short edutorial has described the preferred approach and algorithm for antegrade crossing of the three authors involved. These basic principles may be considered and adopted by any physician, including vascular trainees, who are active in lower extremity PAD interventions.

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