



Editorial

Guide catheter extension systems: Hype or a need?



A B S T R A C T

Keywords:

Guide catheter extension system
Complex PCI
Coronary artery disease

Guide catheter extension system (GCES) is a valuable tool for interventional cardiologists, especially in complex cases. GCES increases guide back-up support and is crucial in complex PCI procedures, particularly in cases of severe calcification and tortuosity. Apart from their primary use to increase back-up support of guide by providing coaxial alignment, deep intubation and facilitation of stent delivery, GCES are now being increasingly used in different clinical indications including complex and high-risk coronary intervention interventions.

© 2021 Cardiological Society of India. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Percutaneous coronary intervention (PCI) is an established technique for management of coronary artery disease (CAD) which includes both acute coronary syndrome (ACS) and chronic coronary syndrome (CCS). This procedure is continuously and rapidly evolving and is often preferred over coronary artery bypass grafting (CABG), even in complex anatomy. Among many causes of procedural failure, failure to deliver equipment (stent/balloon/thromboaspiration device/rotablation catheter/coils etc.) is frequent. The main factors which lead to failure of equipment delivery include poor back-up force, poor axial alignment (increased friction between rigid stent and vessel wall), and increased tortuosity of the target vessel. To overcome the aforementioned obstacles, many strategies such as improved lesion preparation, increased use of stiffer guide-wires, buddy wire technique, and increased guide support have been employed over the years. Various techniques to increase guide support include passive techniques (larger guide dimensions and switching to Amplatzer left (AL) over Judkins) and active techniques (deep intubation of same guide, use of balloon/microcatheter, and guide catheter extension). Guide catheter extension system (GCES) increases guide back-up support and is crucial in complex PCI procedures, particularly in cases of severe calcification and tortuosity. GCES provides coaxial guide extension over mono-rail support. GCES has been utilized in both femoral and radial approaches for native coronary, graft, and peripheral interventions with success rates above 90%.^{1–4} With as little as 5 mm of extension, bench testing has shown that the GCES significantly increases back-up support of a standard 6F guide catheter and provides superior deliverability. In the current era of trans-radial interventions, the main reasons of procedural failure include arterial spasms, failure to puncture access site, failure to cannulate the lesion vessel, lack of adequate guide support, and inability to use guide catheters larger than 7F. Most of these obstacles can be dealt with by certain tips and tricks including use of GCES.⁵ Apart from facilitating stent delivery in calcified and tortuous arteries, GCES are also very useful

in interventions involving coronary arteries of anomalous origin, severe proximal obstructions, graft interventions, chronic total occlusion (CTO) interventions (reverse CART), and other circumstance such as distal vessel stenting, distal drug/device delivery, foreign body retrieval from the coronaries/arterial system, coronary imaging, and distal debulking (rotablation) procedures.^{6–16}

2. Various guide catheter extension systems

At least 7 GCES have been either previously or currently commercially available according to different geographies of the world. These include GuideLiner V3 Catheter (Teleflex, USA), Guidezilla II Guide Extension Catheter (Boston Scientific, USA), TrapLiner Catheter (Teleflex, USA), Telescope Guide Extension Catheter, (Medtronic, USA), Guideplus Catheter (Nipro Corp, Japan), Heartrail II Guiding Catheter (Terumo, Japan) and Proxis System (St Jude Medical, USA). Of the above GCES, GuideLiner V3 Catheter, Guidezilla II Guide Extension Catheter, and Telescope Guide Extension Catheter are commercially available in India with limited use in only a few centers in contrast to the west where use of these catheters is widespread. {Table 1} The GuideLiner V3 Catheter, Guidezilla II Guide Extension Catheter, Trapliner Catheter, and Telescope Guide Extension Catheter are flexible tubular catheters that can be advanced deep into the lesion without the need to disconnect the Y-connector. The Heartrail II Guiding Catheter and the Proxis System are 120 cm catheters that are introduced into the guide catheter and require removal of the Y connector.^{5,17,18} The GuideLiner Catheter was the first system in this category which was introduced first by Vascular Solutions, USA and approved by the FDA in 2009.¹⁹ Current third-generation GuideLiner V3 Catheter is a 150 cm catheter with a 25 cm cylinder distally (rapid exchange section), 17 cm half-pipe in the middle (assists equipment delivery to the distal cylinder) and 108 cm pushrod proximally. There are white positioning markers located at 95 cm (single) and 105 cm (double) on the pushrod to assist placement through the guide. On the distal rapid exchange section there are two radiopaque markers, one at the

Table 1
Comparison between different guide catheter extension systems.

	Guideliner V3 Catheter	Guidezilla II Guide Extension Catheter	TrapLiner Catheter	Telescope Catheter
1. Manufacturer	Teleflex	Boston Scientific	Teleflex	Medtronic
2. FDA approval year	2009	2013	2017	2020
3. Total Length	150 cm	150 cm	150 cm	150 cm
4. Length of rapid exchange section	25 cm	25 cm (40 cm on 6F Long)	13 cm	25 cm
5. Pushwire	Rectangular, 108 cm push rod (stainless steel) and 17 cm half pipe	Round and hollow, 125 cm with short hypotube transition	Rectangular, 130 cm push rod with trapping balloon near distal end of push rod.	Round and solid, 125 cm with 10 cm of tapered pushwire (2 step tapering)
6. Polymer channel (cm)	17 cm	No	17 cm	4 cm
6. Trapping balloon	No	No	Yes	No
7. Internal diameter (inches)	0.056 (1.42 mm)	0.057 (1.447 mm)	0.056 (1.42 mm)	0.056 (1.42 mm)
8. Outer diameter (inches)	0.067 (1.70 mm, 5.1 Fr)	0.067 (1.70 mm, 5.1 Fr)	0.067 (1.70 mm, 5.1 Fr)	0.067 (1.70 mm, 5.1 Fr)
9. Radiopaque marker	Radiopaque marker 4 mm from collar and 2 mm from distal tip	Distal marker Band Radiopaque Collar	Radiopaque marker 4 mm from collar and 2 mm from distal tip	3 mm Spade shaped marker band
10. Sizes available	5F, 5.5F, 6F, 7F, and 8F	6F, 6F long, 7F, and 8F	6F, 7F, and 8F	6F and 7F

distal end (2 mm) and one near the proximal end (4 mm). At the distal end of the half-pipe, rapid exchange collar transition is present at the start of the rapid exchange section. The Guideliner is available in 5 sizes: 5F, 5.5F, 6F, 7F, and 8F with same rapid exchange length across all sizes. In terms of diameter, the 6F Guideliner V3 Catheter has an inner diameter of 0.056 inches and outer diameter of 0.065 inches. The Guidezilla Guide Extension Catheter is similar to the Guideliner V3 Catheter in design in terms of the 25 cm soft flexible tube (guide segment) attached to a 120 cm shelf (pushrod). The Guidezilla Guide Extension Catheter was approved by the FDA in July 2013 as a new rapid exchange catheter.²⁰ Current second-generation Guidezilla II Guide Extension Catheter has 4 sizes of 6F, 6F long, 7F, and 8 F with platinum iridium helical collars which improve visibility (Guidezilla Guide Extension Catheter had stainless steel collar). To reduce device interaction in second-generation Guidezilla II Guide Extension Catheter, the length of the hypotube transition was reduced from 19 to 6 mm. In terms of diameter for default 6F, Guidezilla II Guide Extension Catheter has similar outer diameter (1.70 mm) as compared to Guideliner V3 Catheter, but has a larger (1.45 mm) inner-diameter that has more room to deliver devices.²¹ For larger sizes of 7F and 8F, both inner and outer diameter of Guidezilla II are smaller than the respective Guideliner V3 Catheter. The TrapLiner Catheter is developed as a next-generation device to Guideliner GCES, with the added feature of an integrated balloon for trapping a standard 0.014 inch guidewire within a guide catheter. TrapLiner Catheter was approved by the USFDA in February, 2017. TrapLiner Catheter is very similar to Guideliner V3 Catheter but the difference is that the cylinder is shorter (13 cm rapid exchange section) and there is balloon in the pushrod that can be used to trap the guidewire and remove equipment without the need of an additional trapping balloon.²² This balloon is situated near the distal end of pushrod with a gold marker band under the proximal end of the balloon. The Telescope Guide Extension Catheter is the latest commercial device available which is similar to the two aforementioned predecessors with few differences. These differences include color-coded hub (matching conventional industry French size), solid round proximal pushwire design and 2 mm soft flexible polymer tip different from main jacket. Similar to its predecessors, Telescope Guide Extension Catheter has 125 cm pushrod proximally and

25 cm rapid exchange section distally. The pushrod of telescope is solid and round made up of stainless steel reinforced coil unlike Guideliner V3 Catheter which has a rectangular pushwire and Guidezilla Guide Extension Catheter which has a round and hollow pushwire. Telescope Guide Extension Catheter pushrod has two tapering starting at 115 cm and 124 cm from proximal end. Distal to the pushwire, there is polymer on-ramp followed by entry port and distal exchange section.²³

3. How to deliver guide catheter extension system

GCES has been utilized in both femoral and radial approaches for native coronary, graft, and peripheral interventions. These can be inserted inside compatible guides over monorail support without the need to exchange the system. Though it can be advanced in the vessel by standard methods, to prevent vessel injury, preferred methods are balloon assisted tracking technique (BTT) and balloon surfing technique (BST). In BTT, a balloon is placed in the coronaries downstream the guide extension. It is then advanced by pushing it forward while holding the inflated balloon in place. When it reaches the balloon edge, it is deflated and the catheter is advanced over it. In BST, a small balloon is inflated at the end of the guide-extension catheter, partially protruding into the artery to form a soft tip.

4. Uses of guide catheter extension system

There can be various uses of GCES depending on clinical setting and anatomical substrate. (Table 2) Most common and established use of GCES is equipment delivery. Delivery of coronary stents specially covered coronary stents is effectively facilitated by GCES which can be lifesaving in emergency clinical scenarios such as coronary perforation. Thus, in the modern era of complex coronary intervention, it is critical to be aware of guide catheter and guide catheter extension system selection and the ability to plan and perform cases where in upfront introduction of GCES can lead to better results rather than resorting to a bail-out strategy as a last resort.

Among all indications where GCES helps in facilitating coronary interventions, its use in complex coronary interventions is of

Table 2
Current uses of guide catheter extension system.

Current uses of Guide catheter extension system
1. Increase backup support and coaxial alignment in percutaneous coronary interventions
2. To deliver devices in calcified and tortuous vessels
3. Percutaneous coronary interventions in anomalous coronary artery origin
4. Graft interventions (both venous or arterial)
5. Percutaneous coronary interventions in transcatheter aortic valve replacement valve
6. Chronic total occlusion percutaneous coronary interventions –reverse CART
7. Distal drug delivery in coronary
8. Thrombus aspiration
9. Imaging in proximal coronary bed
10. Foreign body removal/retrieval of entrapped equipment

paramount importance. In severe proximal disease where deep intubation is not possible to deliver distal stents, GCES allows distal stent delivery. Similarly, in cases of severe calcified coronary lesions, where at times device delivery is not possible even after debulking, GCES slips through irregular calcified segment and aids in stent delivery. Additionally GCES helps in delivering rotablation catheters in distal calcified segments, when the proximal segment does not need debulking/or has already a placed previous stent.^{5,21,24} Another important use in rotablation cases is in bifurcation PCI where maintaining two wires at a time can be feasible with employment of GCES. In tortuous arteries where stent delivery is extremely difficult without adequate guide support, GCES can safely cannulate deep within the vessel to facilitate stent delivery. In CTO interventions, GCES has been proven very useful especially in controlled antegrade and retrograde tracking (CART) technique.^{8,20,22} In post CABG interventions, GCES is of enormous help, especially in saphenous vein graft (SVG) PCI where several difficulties are frequently encountered. These difficulties includes inadequate guide catheter support, inability to deeply cannulate guide catheter, inability to reach ostium and cannulate the SVG, and extreme tortuosity which leads to high failure rate in graft PCI.^{7,25} GCES helps in anomalous coronary intervention where cannulation and guide support is usually poor and equipment delivery is almost always challenging. Left circumflex artery (LCx) from right sinus and right coronary artery (RCA) from left sinus are among the most common anomalies encountered in day to day practice and any intervention in these substrates can be challenging especially if associated with severe disease. Major challenges in these anomalous arteries includes target artery cannulation, co-axial alignment and guide support.^{9,26} To overcome these challenges, GCES have been proven very useful tools in recent years.

In distal vessel stenting where stent delivery is difficult due to poor support, GCES provides superior pushability and enhanced deliverability.⁶ In cases of slow-flow and no-flow conditions, distal drug delivery can be delivered with GCES without much difficulty.¹² Similarly GCES can be used for coil embolization in cases of distal perforations.¹⁰ Though not an established indication, GCES can also be used for thrombus aspiration, especially when GCES is already in use for another indication.¹² Rarely, in cases where part of any device embolizes in the distal vessel, GCES plays a crucial in retrieval of these foreign bodies.^{13,14} Another important use of GCES can be coronary imaging where it can play an important role. New Telescope Catheter can image the outside lumen of catheter and can provide useful tool for difficult imaging like in left main.¹⁵

5. Complications

The most concerning complication associated with GCES has been vessel dissection with reported incidence of 1–5%. Other

complications reported previously are longitudinal stent deformation, dislodgement of the cylinder portion of GCES, air embolism, and forceful GCES injection causing vessel dissection.^{27–31}

6. Conclusion

Since the introduction of GuideLiner Catheter in 2009, GCES has come a long way. GCES are very valuable tools for interventional cardiologists, especially in complex cases. Apart from their primary use to increase back-up support of guide by providing coaxial alignment, deep intubation and facilitation of stent delivery, GCES are now being increasingly used in different clinical indications including complex and high-risk coronary intervention interventions. GCES use allows the operator to change strategy during the procedure in difficult anatomy due to its rapid exchange nature and ease of use. Due to their soft tip and flexible delivery, they provides extremely safe deep cannulation which was otherwise not possible with standard guide catheters.

References

- Mamas MA, Fath-Ordoubadi F, Fraser DG. Distal stent delivery with Guideliner catheter: first in man experience. *Cathet Cardiovasc Interv.* 2010;76:102–111.
- Farooq V, Mamas MA, Fath-Ordoubadi F, Fraser DG. The use of a guide catheter extension system as an aid during transradial percutaneous coronary intervention of coronary artery bypass grafts. *Cathet Cardiovasc Interv.* 2011;78:847–863.
- De Man F, Tandjung K, Hartmann M, et al. Usefulness and safety of the GuideLiner catheter to enhance intubation and support of guide catheters: insights from the Twente GuideLiner registry. *EuroIntervention.* 2012;8:336–344.
- Dursun H, Taştan A, Tanrıverdi Z, Özel E, Kaya D. GuideLiner catheter application in complex coronary lesions: experience of two centers. *Anatol J Cardiol.* 2016;16:333–339.
- Ma M, Diao K-y, Liu X-j, He Y. Early clinical experience with Guidezilla for transradial interventions in China. *Sci Rep.* 2018;8:1–8.
- Kassimis G, Raina T. GuideLiner extension catheter-facilitated side strut stenting technique for the treatment of right coronary artery ostial in-stent restenosis. *Cardiovasc Revascularization Med.* 2018;19:133–136.
- Vishnevsky A, Savage MP, Fischman DL. GuideLiner as guide catheter extension for the unreachable mammary bypass graft. *Cathet Cardiovasc Interv.* 2018;92:1138–1140.
- Mody R, Dash D, Mody B. *Sahali A Guide Extension Catheter-Facilitated Reverse Controlled Antegrade and Retrograde Tracking for Retrograde Recanalization of Chronic Total Occlusion.* Case Rep Cardiol 2021; 2021.
- Senguttuvan NB, Sharma SK, Kini A. Percutaneous intervention of chronic total occlusion of anomalous right coronary artery originating from left sinus—Use of mother and child technique using guideliner. *Indian Heart.* 2015;67:S41–S42.
- Kodaira M, Numasawa Y. Successful percutaneous coil embolization of a severely tortuous coronary artery fistula using the mother-child-grandchild technique via a GuideLiner catheter. *SAGE Open Med Case.* 2017;5:2050313X16672382.
- Graidis C, Dimitriadis D, Karasavvidis V. GuideLiner catheter facilitated percutaneous coronary artery intervention of an anteriorly displaced and heavily calcified right coronary artery. *J Invasive Cardiol.* 2012;24:E222–E224.
- Fry J, Naqvi A, Bahia A, Seto. A Aspiration thrombectomy and intracoronary tirofiban via GuideLiner catheter for a thrombosed aneurysmal vessel. *Future Cardiol.* 2017;13:131–135.
- Tsujimura T, Ishihara T, Iida O, et al. Successful percutaneous retrieval of a detached microcatheter tip using the guide-extension catheter trapping technique: a case report. *J Cardiol Cases.* 2019;20:168–171.
- Chiang C-H, Liu S-C. Successful retrieval of an entrapped rotablator burr by using a Guideliner guiding catheter and a snare. *Acta Cardiol Sin.* 2017;33:96–98.
- Garcia-Guimaraes M, Cuesta J, Rivero F, et al. Mother-and-child catheter-facilitated optical coherence tomography: a novel approach to improve intracoronary imaging. *Cardiol.* 2016;23:647–651.
- Yoshida R, Ishii H, Tanaka A, et al. Differences in primary indication for guide-extension catheter usage among the three target vessels. *Postepy Kardiologii Interwencyjnej* 2020; 16:192–197.
- Mamas M, Fath-Ordoubadi F, Fraser D. Successful use of the Heartrail III catheter as a stent delivery catheter following failure of conventional techniques. *Cathet Cardiovasc Interv.* 2008;71:358–363.
- Mamas MA, Eichhöfer J, Hendry C, et al. Use of the Heartrail II catheter as a distal stent delivery device; an extended case series. *EuroIntervention.* 2009;5:265–271.
- Huang M-S, Wu C-I, Chang F-H, et al. The efficacy and safety of using extension catheters in complex coronary interventions: a single center experience. *Acta Cardiol Sin.* 2017;33:468–476.

20. Huang Z, Zhang B, Chai W, et al. Usefulness and safety of a novel modification of the retrograde approach for the long tortuous chronic total occlusion of coronary arteries. The Guidezilla Reverse-CART Technology. *International Heart*. 2017;58:351–356.
21. Kumar P, Aggarwal P, Sinha SK, et al. The safety and efficacy of Guidezilla Catheter (Mother-in-Child Catheter) in complex coronary interventions: an observational study. *Cardiol Res*. 2019;10:336–344.
22. Kaier TE, Kalogeropoulos A, Pavlidis AN Guide-extension facilitated antegrade dissection re-entry: a case series. *J Invasive Cardiol*. 2020;32:E209–E212.
23. Rumoroso JR. *Telescope Guide Extension Catheter*. REC Publications; 2019 [cited 2019 30/06/19]; Available from: <https://recintervcardiol.org/en/innovation-in-interventional-cardiology/telescope-guide-extension-catheter>.
24. Chan PH, Alegria-Barrero E, Foin N, et al. Extended use of the GuideLiner in complex coronary interventions. *EuroIntervention*. 2015;11:325–335.
25. D'Amario D, Galli M, Vergallo R, Crea F, Porto I How deep is your lesion? Extreme guideliner V3 intubation through RIMA graft to treat a distal left anterior descending artery stenosis. *J Cardiovasc Med (Hagerstown)*. 2018;19:606–608.
26. Bali HK, Dhindsa A, Bharti S. An anomalous story of a rare percutaneous intervention to left anterior descending/right coronary artery bifurcation. *Clin Case Rep*. 2021;9, e03764.
27. Papayannis AC, Michael TT, Brilakis ES Challenges associated with use of the GuideLiner catheter in percutaneous coronary interventions. *J Invasive Cardiol*. 2012;24:370–371.
28. Murphy JC, Spence MS guideliner catheter—friend or foe? *Cathet Cardiovasc Interv*. 2012;80:447–450.
29. Arnous S, Shakhshir N, Wiper A, et al. Incidence and mechanisms of longitudinal stent deformation associated with Biomatrix, Resolute, Element, and Xience stents: angiographic and case-by-case review of 1,800 PCIs. *Cathet Cardiovasc Interv*. 2015;86:1002–1011.
30. Tariq Bhat M, Hassan Baydoun M, Frank Tamburino M. A unique complication with use of the GuideLiner catheter in percutaneous coronary interventions and its successful management. *J Invasive Cardiol*. 2014;26:E42–E44.
31. Chang YC, Fang HY, Chen TH, Wu CJ Left main coronary artery bidirectional dissection caused by ejection of guideliner catheter from the guiding catheter. *Cathet Cardiovasc Interv*. 2013;82:E215–E220.

Sharad Chandra

Department of Cardiology, King George's Medical University,
Lucknow, Uttar Pradesh, 226003, India
E-mail address: sharadaiims@gmail.com.

Ashish Tiwari*

Department of Cardiology, King George's Medical University,
Lucknow, Uttar Pradesh, 226003, India

Gaurav Chaudhary

Department of Cardiology, King George's Medical University,
Lucknow, Uttar Pradesh, 226003, India
E-mail address: gauravchaudharydr@gmail.com.

Rakesh Yadav

Department of Cardiology, AIIMS, New Delhi, India
E-mail address: rakeshyadav123@yahoo.com.

* Corresponding author.

E-mail address: aashishtiwari@live.com (A. Tiwari).

10 September 2021

Available online 16 September 2021