

Micro Catheters in Interventional Cardiology

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Abstract

Keywords

- ▶ interventional cardiology
- ▶ micro catheter
- ▶ hardware

Microcatheters are commonly used hardware during complex coronary and cerebral interventional therapies. With increasing operator experience, more and more complex coronary interventions are being done in day-to-day practice and especially with chronic total occlusions. Various types of micro catheters are available in the market with each manufacturer having unique design and purpose. This review summarizes the various available and commonly used microcatheters in interventional cardiology

Introduction

Catheter is a hollow tube with one end having port to connect to the pressure monitor or to pass a thin caliber wire through it and other end being soft and hollow to engage or pass it into an artery or structure. Micro means actually very small, but it is used here to denote small catheter as they are very low in profile. These catheters are 2 to 2.5F in diameter and lengths vary from 100cm to 150cm. The wall may be made of polyethylene or could be reinforced with coils or braided within the wall for better support, push ability or to make them kink resistant. The tip of the micro catheter has a radio opaque marker. Even though there are varieties of microcatheters used in interventional cardiology such as angiography microcatheter (to inject contrast or medicine or embolic materials or perfusion to distal bed), access microcatheters (small vessel or super selective anatomy for diagnostic and interventional procedures), guiding microcatheters, and next-generation fractional flow reserve microcatheter technology, this review mainly discusses about percutaneous coronary intervention (PCI) microcatheters.

Types of Micro Catheters

1. Single lumen micro catheters¹: mainly used for crossing support and distal injections
2. Dual lumen micro catheters^{2,3}: mainly used for guidewire placements and exchanges, parallel wire or buddy wire after complex channel crossing, for angulate side branch wiring, and to avoid tangling of the guidewires.⁴

Functions of Micro Catheters

Multiple ways to use the microcatheters in different interventional scenarios are described.⁵

1. For complex chronic total occlusion (CTO) antegrade approach: increases wire support and penetration force, makes parallel wire and sea saw techniques easier and allows wire exchanges easy.
2. For complex CTO retrograde approach: increases the wire support and accesses the collaterals with latest generation wires.

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Table 1 Description of different microcatheters (courtesy of city today website)

Company name	Product name	Type of catheter construction	Proximal size (F)	Middle size (F)	Distal catheter size working length (F) length (cm)	Catheter endholeID (inch)	Recommended guidewire size (inch)	Radiopaque tip (Yes/No)	Hy Coat	drophilic ing (- Yes/No)
Acrostak	M-Cath	Stainless steel covered with blue Teflon (PTFE)	2.1	2.1	2.25	135	0.016	0.014	Yes	Yes
Asahi Intecc USA, Inc.	Asahi Caravel	Stainless steel braided	2.6	1.9	1.4	135, 150	-	0.014	Yes, tungsten powder 5-mm tip	Yes
Asahi Intecc USA, Inc.	Asahi Corsair/Corsair Pro	Stainless steel braided	2.8	2.6	1.3	135, 150	-	0.014	Yes, tungsten powder 5-mm tip	Yes
Asahi Intecc USA, Inc.	Tornus	Stainless steel braided	3.3	2.1	1.8	135	-	0.014	Yes	No
Asahi Intecc USA, Inc.	Tornus 88 Flex	Stainless steel braided	4.1	2.6	2.1	135	-	0.014	Yes	No
Baylis Medical Company, Inc.	ProTrack Microcatheter	Coiled stainless steel, PTFE, Pebax	2.7	2.7	2.7	145	0.022	Up to 0.021	Yes	No
Baylis Medical Company, Inc.	ProTrack Microcatheter	Coiled stainless steel, PTFE, Pebax	2.9	2.9	2.9	145	0.025	Up to 0.024	Yes	No
Boston Scientific Corporation	Mamba 135 Microcatheter	Coil	2.9	2.4	1.4	135	0.018	0.014	Yes	Yes
Boston Scientific Corporation	Mamba Flex 135 Microcatheter	Coil	2.9	2.1	1.4	135	0.018	0.014	Yes	Yes
Boston Scientific Corporation	Mamba Flex 150 Microcatheter	Coil	2.9	2.1	1.4	150	0.018	0.014	Yes	Yes
Cardiovascular Systems, Inc. (manufactured by OrbusNeich)	Teleport Control Microcatheter	Stainless steel braid and coil with outer nylon Pebax jacket	2.7	-	2.1	135, 150	0.0157	0.014	Yes	Yes
Cardiovascular Systems, Inc. (manufactured by OrbusNeich)	Teleport Microcatheter	Stainless steel braid and coil with outer nylon Pebax jacket	2.6	-	2	135, 150	0.0157	0.014	Yes	Yes
Cook Medical	Cantata 2.5	Braided stainless steel, PTFE, Pebax	2.5	2.5	2.5	100, 110, 135, 150	0.021	0.018 (maximum)	Yes	Yes
Cook Medical	Cantata 2.8	Braided stainless steel, PTFE, Pebax	2.8	2.8	2.8	100, 110, 135, 150	0.025	0.021 (maximum)	Yes	Yes
Cook Medical	Cantata 2.9	Braided stainless steel, PTFE, Pebax	2.9	2.9	2.9	100, 110, 135, 150	0.027 (0.69 mm)	0.025 (maximum)	Yes	Yes
Merit Medical Systems, Inc.	SwiftNinja Steerable Coronary Microcatheter	Tungsten-braided shaft	2.9 (0.97 mm)	2.9 (0.97 mm)	2.4 (0.80 mm)	125	0.021 (0.54 mm)	0.018	Yes, two markerbands	Yes
Millar, Inc.	Mikro-Cath	Nylon tube	2.3	-	3.5	120	-	Guide catheter used for delivery	No	No

Table 1 (Continued)

Company name	Product name	Type of catheter construction	Proximal size (F)	Middle size (F)	Distal catheter size working (F) length (cm)	Catheter endholeID (inch)	Recommended guidewire size (inch)	Radiopaque tip (Yes/No)	Hy Coat	drophilic ing (- Yes/No)
Reflow Medical, Inc	Wingman 14C Crossing Catheter	Braided catheter with extendable beveled tip	2.7	2.7	2.7	-	-	0.014	Yes	Yes
Teleflex	Minnie Support Catheter 0.014	Polymer	3.1	2	1.6	135, 150	-	0.014	No; three radiopaque marker bands near distal tip	Yes
Teleflex	SuperCross Microcatheter OTW - 0.014 Angled Tips: 45°, 90°, 120°, and 90° Extended Tip	Dual coil design, platinum/tungsten coil tip	3.2	-	2.4	130, 150	0.017	0.014	Yes, platinum/tungsten coil tip	Yes
Teleflex	SuperCross Microcatheter OTW - 0.014 Straight and Flexible Tip	Braided	2.5	-	1.8	130, 150	0.017	0.014	Yes, one markerband	Yes
Teleflex	Turnpike Catheter	Hybrid multilayer: dual bidirectional coils with inner braid	2.9	2.6	1.6	135, 150	0.0165	0.014	Yes, tungsten-loaded tip	Yes
Teleflex	Turnpike Gold Catheter	Hybrid multilayer: dual bidirectional coils with inner braid and external nylon spiral coil	2.9	2.9	2.1	135	0.0165	0.014	Yes, gold-plated tip	Yes
Teleflex	Turnpike LP Catheter	Hybrid multilayer: dual bidirectional coils with inner braid	2.9	2.2	1.6	135, 150	0.0165	0.014	Yes, tungsten-loaded tip	Yes
Teleflex	Turnpike Spiral Catheter	Hybrid multilayer: dual bidirectional coils with inner braid and external nylon spiral coil	2.9	2.9	1.6	135, 150	0.0165	0.014	Yes, tungsten-loaded tip	Yes
Teleflex	Twin-Pass Dual Access Catheter	Dual-lumen catheter	3	3.5	2	135	0.017	0.014 (RX and OTW)	Yes, two markerbands	Yes
Teleflex	Twin-Pass Torque Dual Access Catheter	Dual-lumen catheter	3.5 × 3.5		2.1	135	0.017	0.014 (RX and OTW)	Yes, two markerbands	Yes
Terumo Interventional Systems	FineCross MG Micro Guide	Stainless steel braid, hydrophilic coating, tapered inner shaft, floppy distal 1.3- cm segment	2.6	-	1.8	130, 150	0.018	0.014	Yes	Yes

- For complex tortuous distal lesions: provide better support to the guidewire to go more distally and make exchange of guidewires quicker.
- Bifurcation PCI with or without acute side branch: side branch access made easier especially with twin lumen catheters and with steerable tip micro catheters.⁶
- Distal vessel assessment with contrast injections and also to deliver the drugs distally into the vascular bed and myocardium. However, we need to exercise caution to de-air the catheter properly and also make sure that the catheter tip is in the true lumen and not in the dissected plane. When blood is seen at the hub of the microcatheter with or without very gentle aspiration, it confirms the distal correct luminal position of the catheter.
- In future, these could become useful in making intracoronary imaging more trouble free (in pipe line research to enable placement of imaging catheter distally).

The above-mentioned function that is injecting contrast is used in microcatheter-facilitated primary angioplasty in ST-segment elevation myocardial infarction to do direct stenting and achieve effective thrombolysis in myocardial infarction (TMI) 3 flow distally.⁷ Similarly, microcatheter distal perfusion technique can be used in bail out coronary perfusion.⁸

Varieties of the Microcatheters

Most commonly used coronary MCs⁵ are Corsair and Corsair Pro (Asahi Intecc, Aichi, Japan), Caravel (Asahi Intecc), Finecross (Terumo, Somerset, NJ, USA), and the Turnpike family: Turnpike, Turnpike LP, Turnpike Gold, and Turnpike Spiral (Teleflex, Wayne, PA, USA). The details of mostly available catheters with their details are mentioned in ► **Table 1**. With torsion catheter, screwing technique (torquing and retorquing) is used to advance the microcatheter, which is improved to corsair now⁹. Most of the microcatheters has a single radiopaque marker at the tip but Fineduo microcatheter has two radiopaque markers facilitating the access of side branch or collateral or the distal most stent strut.

Recent Microcatheters

Now, the next generation of corsair, corsair Pro XS with more trackability is available. Navitian (iVascular, USA) microcatheter is specially design to navigate the CTO lesions due to the internal and external conical transition.

Uses and Causations during Usage of the Microcatheters

The specific advantage of Corsair and turnpike is to torque and thread the microcatheter in tough and tortuous lesions. This is because of their tapered and low profile tips along with braiding. However, one should be careful in calcific lesions while using corsair. In mild calcification at lesion site or in the artery, the corsair can be used, but in heavily calcified lesions, entrapment of corsair can occur. The caravel and fine cross micro catheters are used generally to push the

Table 2 Characteristics of dual lumen microcatheters

Device	Catheter length (cm)	Distance (RX-OTW mm)	Proximal OD (F)	Distal OD (F)	Tip OD(F)	Distal shaft shape	Inner lumen ID	GW compatibility (inch)	GC compatibility (F)
Twin pass	135	3.4/2.7	2	2	2	Oval	0.016- inch RX: 0.0165-inch OTW	0.014	≥ 5
Twin pass Torque	135	3.5	2.1	2.1	2.1	Round	0.015- inch RX: 0.0155-inch OTW distal; 0.0165-inch OTW proximal	0.014	≥ 5
Sasuke	145	3.2	2.5/3.3	1.5	1.5	Oval	0.016-inch tip and 0.017 inch shaft	0.014	≥ 5
NHancer Rx	135	2.6	2.3	1.5	1.5	Oval	0.019-inch tip and shaft	0.014	≥ 5
ReCross	140	2.6/3.4	2.3/3.3	1.5	1.5	Oval	0.019-inch tip and shaft	0.014	≥ 5
Fineduo	140	2.9	22	22	22	Round	0.017-inch tip and shaft	0.014	≥ 5
Crusade	140	2.9	22	–	–	Round	0.017-inch tip and shaft	0.014	–

Abbreviations: GC, guiding catheter; GW, guidewire; ID, inner diameter; OD, outer diameter; OTW, over the wire; RX, rapid exchange.

Table 3 Steerable and angle tip microcatheters: comparison of venture wire control, supercross, and swifNINJA microcatheters (courtesy of George Kassimis et al)


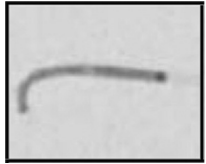
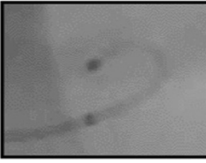
Parameters	Venture wire control	Supercross	SwifNINJA
Type of microcatheter	Steerable, Available in RX, and OTW	Fixed curve OTW	Steerable OTW
Tip of microcatheter	Deflects up to 90°*	Angled in 45°, 90° and 120°	Deflects up to 180°
Guidewire compatibility	0.014"	0.014"	0.014"
Guide catheter compatibility	6F	6F	6F
Working length in cm	145(RX), 140 (OTW)	130 and 150	125
RX segment length in cm	30	n/a	n/a
Radiopacity	8mm radiopaque tip length 	Along entire angled tip 	Two radiopaque markers 
Hydrophilic coating length in cm	Distal 24 (RX), distal 45 (OTW)	Distal 80	Distal 80
Inner diameter	0.018" (0.46 mm)	Distal 0.017" (0.43 mm) Proximal 0.018" (0.46 mm)	0.021" (0.54 mm)
0.021" (0.54 mm)	2.2 F(0.74 mm)	2.4F (0.71 mm)	2.4F (0.80 mm)

Table 4 Microcatheter failure mechanisms and clinical consequences according to Megaly's et al study

Failure method, n (%)	N = 378
Tip fracture	305(80.7%)
Due to over-torquing	141
Due to forceful pulling	81 (26.6%)
Tip was retrieved	109 (35.7%)
Tip stuck in the lesion	127 (33.6%)
Guidewire stuck in the micro catheter	39 (10.3%)
Proximal shaft and hub separation	20 (5.3%)
Shaft fracture and twisting	4 (1.1%)
Outer coil or polymer dislodgement	8 (2.1%)
Clinical consequences n (%)	
Death	3 (0.8%)
Perforation	7 (1.9%)
Dissection	5 (1.3%)
Surgery	27 (7.1%)
Aborted percutaneous coronary intervention	55 (14.6%)
Periprocedural myocardial infarction	3 (0.8%)

catheter over the wire without torquing when the arteries are softer and relatively without much coils. The contrast injection and drug delivery are better in fine cross due to better lumen inside. The steerable tip and twin lumen catheters (►Table 2) are obvious choice for bifurcation PCI to access the angulated side branches. Also, 150 cm length corsair is used for exteriorization of the coronary wire during retrograde CTO technique. Comparison characteristics of a few microcatheters that are steerable and angle tip are mentioned in ►Table 3.

Complications of Micro Catheter Usage

According to Megaly et al's study, the most common complication of the micro catheter usage is tip fracture and the guidewire getting stuck in the lesion and the most commonest clinical consequence is procedure abandonment

and surgery and very rarely perforation and death¹⁰ (►Table 4).

Conclusions

Coronary micro catheters are essential tools in today's era of contemporary complex PCI. They have significant utility in CTO PCI and are mandatory for retrograde CTO PCI. The operators need to be aware of the various types of micro catheters available and know the advantages and specific scenarios in which each one could be preferred. It is also important to know how to use them carefully to avoid complications during PCI.

Conflict of Interest

None declared.

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