Case Report / *Olgu Sunumu*

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A case of successful management of a trapped and fractured microcatheter tip during a complex CTO intervention

Kompleks bir CTO müdahalesi sırasında sıkışan ve kopan bir mikrokateter ucu için başarılı bir yönetim vakası

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ABSTRACT

Chronic total occlusions (CTOs) represent one of the most technically challenging subsets in coronary artery disease interventions, frequently complicated by severe calcification and difficult vessel anatomy. Microcatheters play a crucial role in CTO percutaneous coronary intervention (PCI), but their use can lead to rare complications such as tip entrapment and fracture, especially in calcified lesions. We present a case of microcatheter tip fracture during complex right coronary artery CTO PCI, managed successfully by employing a parallel-wire technique to bypass the fractured segment followed by stent deployment to crush and trap the fragment against the vessel wall. This approach resulted in complete revascularization without adverse events. The case highlights the importance of understanding device limitations, preparing for procedural complications, and utilizing alternative strategies such as the balloon-assisted sliding technique. As coronary calcification prevalence rises, awareness and effective management of such complications are increasingly critical for optimal patient outcomes.

Keywords: Coronary occlusion, chronic total, catheter fracture, coronary artery calcification, balloon-assisted sliding

ÖZ

Kronik total tıkanıklıklar (KTO), koroner arter hastalığında teknik olarak en zorlu müdahale alanlarından biridir ve sıklıkla şiddetli kalsifikasyon ve zor damar anatomisi ile komplike olabilir. Mikrokateterler KTO perkütan koroner girişiminde (PKG) önemli bir rol oynar, ancak özellikle kalsifiye lezyonlarda uç sıkışması ve kırılması gibi nadir komplikasyonlara yol açabilirler. Bu çalışmada, sağ koroner arterdeki karmaşık KTO PKG sırasında mikrokateter ucu kırılması olgusu sunulmuştur. Kopan segmentin yanından paralel tel tekniği kullanılarak geçiş sağlanmış ve ardından mikrokateter parçası stent ile damar duvarı arasına ezilerek sabitlenmiştir. Bu yöntemle komplikasyon olmadan tam revaskülarizasyon sağlanmıştır. Olgu, kullanılan malzemelerin mekanik sınırlarının iyi anlaşılmasının, prosedürel komplikasyonlara hazırlıklı olunmasının ve balon destekli kaydırma tekniği gibi alternatif stratejilerin kullanılmasının önemini vurgulamaktadır. Koroner kalsifikasyonun artan prevalansı göz önüne alındığında, bu tür komplikasyonların farkındalığı ve etkin yönetimi optimal hasta sonuçları için giderek daha kritik hale gelmektedir.

Anahtar Sözcükler: *Kronik total tıkanıklık, kateter kopması, koroner arter kalsifikasyonu, balon destekli kaydırma*

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INTRODUCTION

Chronic total occlusions (CTOs) are among the most technically demanding subsets of coronary artery disease, posing significant challenges related to procedural complexity, operator expertise, potential complications, and procedural success. Commonly encountered during diagnostic coronary angiography, CTOs are defined as complete occlusion of the coronary lumen persisting for more than three months (1). The intricacies of coronary anatomy such as severe calcification, convoluted thoracic vascular structures, a poorly defined proximal cap, and distal vessels visualized only through collateral flow, further compound the difficulty, elevating the risk and duration of percutaneous coronary interventions (PCI). CTO-specific PCI carries a higher complication rate compared to non-CTO PCI, largely due to extended procedural times, the necessity for advanced equipment, and the critical role of operator experience. Microcatheters are indispensable in the CTO PCI toolkit, facilitating guidewire manipulation, enhancing support, and enabling safe exchange(2). They also allow for selective contrast injections beyond the occlusion to verify lumen positioning and assess distal arterial anatomy. Table-1 summarizes the characteristics and clinical applications of microcatheters frequently utilized in chronic total occlusion procedures (3). However, their use in heavily calcified lesions may predispose to complications such as entrapment or tip breakage (4).

We report a case involving the entrapment of the tip of a Caravel microcatheter during a complex right coronary artery (RCA) CTO PCI. This complication was managed successfully via a pragmatic strategy involving a parallel-wire technique to bypass the fractured tip within the calcified plaque, followed by stent deployment.

Table-1. Characteristics and Clinical Applications of Commonly Used Microcatheters in Chronic Total Occlusion Interventions

Microcatheter	Characteristics	Main Applications in CTO
Corsair / Corsair Pro (Asahi)	Braided tungsten shaft, excellent torque transmission, very flexible distal tip	- “Drilling” technique for lesion penetration - Wire support - Wire exchange
Finecross (Terumo)	Very low profile (~1.8 Fr distal), low friction, high deliverability	- Crossing tight proximal lesions - Accessing distal tortuous vessels - Wire exchange
Caravel (Asahi)	Highly flexible tip, low profile, smooth tracking, good torque control	- Tortuous vessel navigation - Preferred in retrograde CTO approach
Turnpike / Turnpike Spiral / Turnpike Gold (Vascular Solutions)	Robust shaft, hydrophobic coating; Spiral version allows rotation; Gold version has metal tip	- Penetrating heavily calcified lesions - Providing strong support - Facilitating difficult wire manipulation
Tornus (Asahi)	Thick shaft, screw-like structure advanced by manual rotation	- Mechanical dilatation of very hard/calcified CTOs - Creating a path where the wire cannot advance
Mamba / Mamba Flex (Boston Scientific)	Flexible distal segment, good torqueability, variable support	- Wire manipulation during CTO crossing -Wire exchange - Providing stability in moderately complex lesions
Dual-lumen catheters (Crusade, Twin Pass, ReCross)	Two lumens (main wire + side wire); good support and wire control	- Side branch wiring - Re-entry techniques - Parallel wire strategy

The general characteristics of each microcatheter were obtained from the manufacturers’ official instructions for use (IFU) and product manuals.

CASE REPORT

A 61-year-old male, with a longstanding history of active smoking and type 2 diabetes mellitus over three years, presented with unstable angina pectoris and underwent diagnostic coronary angiography. Imaging revealed a 90% stenosis in the proximal left anterior descending artery (LAD) and a chronic total occlusion (CTO) in the proximal right coronary artery (RCA). Rentrop grade 2–3 collateral circulation was noted in the distal RCA, supplied via both retrograde septal collaterals from the LAD and antegrade bridging collaterals from the proximal RCA (Figure-1A). The J-CTO score was calculated as 1, reflecting moderate calcification of the CTO lesion. During the index procedure, PCI to the LAD was successfully performed. One month later, a CTO-PCI was undertaken for the RCA. A 6F AL2 guide catheter was engaged at the RCA ostium via a bifemoral approach, while a 6F JL4 guide catheter was positioned in the left main coronary artery (LMCA). An antegrade crossing strategy was initially attempted using a Corsair (Asahi) microcatheter combined with Gaia Second (Asahi) and Pilot 200 (Abbott) guidewires for proximal cap penetration. After limited advancement, due to the tapered and hydrophilic tip, the wires were exchanged for a Fielder XT-A (Asahi), which successfully reached the true distal lumen. However, the Corsair microcatheter failed to traverse the proximal cap of the calcific occlusion. It was replaced with a Caravel (Asahi) microcatheter, favored for its lower profile and hydrophilic coating, which succeeded in penetrating the proximal cap but could not be advanced further. Upon attempted retraction, its approximately 3-mm black, tapered tip fractured and remained lodged within the calcified lesion (Figure-1B). The intracoronary wire was left in situ, and a parallel-wire technique was implemented. Initially unsuccessful with the Gaia Second, the lesion was ultimately crossed using a medium-stiffness, tip-weighted AnyreachP 6 (APT Medical) wire, which reached the distal true lumen (Figure-1C). A Corsair microcatheter was then advanced successfully over this wire without resistance. After confirming correct intraluminal positioning by tip-injection, sequential predilatation was performed using CTO balloons of sizes 1.0 × 15 mm, 1.25 × 15 mm, and 2.0 × 10 mm, re-establishing distal flow. During stent deployment, the stent could not traverse the RCA trunk. A guide-extension catheter was attempted but failed to advance distally, even when using the distal anchor technique. Ultimately, the balloon-assisted sliding technique enabled successful distal advancement of the extension catheter, and stenting was completed. A 3.0 × 29 mm drug-eluting stent was deployed, crushing the retained microcatheter fragment against the vessel wall (Figure-1D). The final angiogram confirmed complete revascularization without complications (Figure-2).

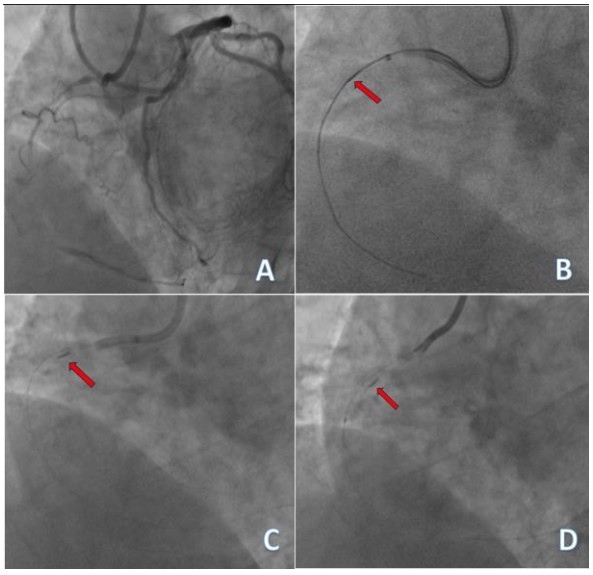

Figure-1. Stages of Right Coronary Artery CTO Intervention.

A. Coronary angiography showing 90% stenosis in the proximal LAD and a CTO in the proximal RCA, with Rentrop grade 2–3 collaterals from both retrograde septal and antegrade bridging vessels.

B. As indicated by the arrow, the approximately 3 mm tapered black tip of the Caravel microcatheter became entrapped and fractured, remaining within the proximal cap.

C. The intracoronary wire was left in place, and the lesion was crossed using a parallel-wire technique with a medium-stiffness wire, after which the initial wire, which remained within the fractured microcatheter, was withdrawn. (indicated by the arrow).

D. As indicated by the arrow, the Caravel microcatheter tip was trapped under the stent and crushed against the vessel wall.

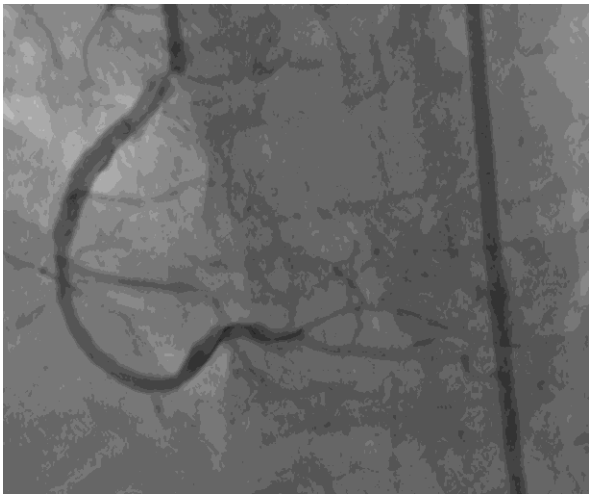

Figure-2. Final view of the right coronary artery

DISCUSSION

This case underscores the technical challenges associated with chronic total occlusion (CTO) percutaneous coronary intervention (PCI) and highlights the potential for rare but significant complications, such as microcatheter tip entrapment and fracture within a coronary artery. Microcatheters like the Caravel are not designed for torque-based manipulation and may prove inadequate, especially in severely calcified and refractory lesions (4). Excessive pushing or pulling force can result in tip entrapment and shearing, particularly in tortuous or heavily calcified vessels. The most frequently reported microcatheter complication is tip fracture (80.7%), commonly caused by over-torquing (46.2%) or forced withdrawal (26.6%) (5). The primary mechanism of failure in low-profile, non-torqueable microcatheters, such as the Caravel, is related to traction and force (6). In cases involving severely calcified lesions, careful selection of appropriate materials is crucial; those unsuitable for such maneuvers should be avoided, and rotational techniques, if employed, should be used with caution or avoided altogether. When complications like microcatheter entrapment and fracture occur, various retrieval strategies, including snare or guidewire-based techniques, may be attempted (7). However, when retrieval carries a high risk of vascular injury, leaving the fractured fragment in situ and subsequently deploying a stent over the fragment is a valid and generally safe alternative. Sadiq et al. (2024) reported a similar case in which the tip of a Caravel microcatheter fractured. They continued the procedure using the wire escalation technique, leaving the fractured fragment in situ. Subsequent examination revealed abrasions and damage to the distal polymer tip of the microcatheter due to calcified plaque. Notably, despite the absence of rotational maneuvers, they emphasized that the slender and flexible design of the Caravel microcatheter predisposes it to entrapment in calcified and angulated segments (6). In a case reported by Hashimoto et al. (2018), the tip of a Caravel microcatheter fractured and became lodged in a heavily calcified mid-LAD segment. The fragment was successfully retrieved using the twin guidewire technique (8).

In the present case, although the operator did not attempt forceful extraction, the fragment was left in place. A parallel wire technique was employed, and the remaining fragment was crushed against the vessel wall by stent deployment, effectively trapping it between the vessel wall and the stent struts. This approach resulted in complete vascular patency and resolved the complication without further adverse events. The outcome was excellent, achieving successful revascularization without complications. This case emphasizes the importance of understanding the mechanical limitations of interventional devices, anticipating potential complications, and having alternative strategies readily available. Furthermore, the rising incidence of coronary calcification—due to an aging population and increasing prevalence of comorbidities such as diabetes and chronic kidney disease—makes the recognition and management of such complications increasingly relevant in routine clinical practice. Operators must be well-versed in the characteristics and limitations of microcatheters and develop both preventive and corrective strategies to effectively manage these rare but critical events.

A secondary learning point from this case is the value of considering alternative, solution-focused techniques, such as the balloon-assisted sliding method, to enhance procedural success. Technically, balloon-assisted tracking and sliding are closely related methods. In both techniques, the guidewire is positioned within the extension catheter, with half of the balloon extending beyond the catheter lumen. Balloon-assisted tracking involves inflating the balloon at high pressure to compress the catheter, allowing the balloon and catheter to be advanced together. Conversely, balloon-assisted sliding entails inflating the balloon to prevent catheter compression while using it as a guide, sliding the catheter over the balloon to advance distally (9). While the tracking technique may have a lower

success rate in tortuous and heavily calcified vessels, the sliding technique can offer improved success in such challenging anatomies. The balloon-assisted sliding technique facilitates the advancement of guide extension catheters in tortuous or angulated coronary segments; however, its efficacy is limited in heavily calcified or extremely narrow vessels. Potential complications include vessel dissection, perforation, microcatheter entrapment, and balloon rupture, particularly if excessive force is applied. Careful selection of balloon size and meticulous procedural technique are therefore essential to minimize these risks.

CONCLUSION

This case illustrates the complexity of CTO PCI and the potential for rare complications such as microcatheter tip fracture. Awareness of device limitations, careful procedural planning, and readiness to employ alternative techniques are essential for successful management. Leaving a fractured microcatheter tip in situ and crushing it with a stent can be a safe and effective strategy when retrieval poses high risk. As coronary calcification becomes increasingly prevalent, understanding and managing such complications is crucial for optimal patient outcomes.

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Authors' Note

All authors have substantial contributions to conception and design, or acquisition of data, analysis and interpretation of data; drafting the article or revising it critically for important intellectual content; and final approval of the version to be published.

Ethical approval

Ethical approval was not obtained because it is a case report.

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