



# Kazakhstan CTO Club's recommended guidelines for interventional therapy for coronary chronic total occlusion

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## Abstract

Chronic total occlusion (CTO) disease refers to obstructive coronary artery disease, which is the degree of direct blood flow of the blood flow TIMI 0 degree of occlusion time 3 months, if there are already well-developed collaterals or bridge collaterals, the distance from the occlusion of the blood vessel TIMI blood flow > 0 degree is still considered a total occlusion disease. Previous studies have shown that 20% of patients with coronary heart disease have experienced CTO lesion from at least one vessel, Percutaneous Coronary Intervention (PCI) surgery is called the "last fortress" in the field of coronary intervention because of the low success rate and high complications. Therefore, based on the integration of the clinical experience of our country and the analysis of relevant information and progress in research in this area, Chronic Total Occlusion Club Qazaq (Chronic Total Occlusion Club Qazaq, CTOCQ) developed a proposed method of interventional treatment of Coronary chronic total occlusion in Kazakhstan for reference to interventional doctors.

**Key words:** interventional therapy, chronic, total occlusion, guideline

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## Introduction

Chronic total occlusion (CTO) disease refers to obstructive coronary artery disease, which is the degree of direct blood flow of the blood flow TIMI 0 degree of occlusion time 3 months, if there are already well-developed collaterals or bridge collaterals, the distance from the occlusion of the blood vessel TIMI blood flow > 0 degree is still considered a total occlusion disease [1-2]. Previous studies have shown that 20% of patients with coronary heart disease have experienced CTO lesion from at least one vessel [3], Percutaneous Coronary Intervention (PCI) surgery is called the "last fortress" in the field of coronary intervention because of the low success rate and high complications [2]. Clinical data indicate that the success of CTO lesion revascularization effectively facilitates myocardial ischemia and angina pectoris [4-6], improves left ventricular function [7,8], reduces the need for a bridge in the coronary artery [9,10], and improves clinical recovery [11-15]. According to the results of available clinical trials [16,17], revascularization therapy should be considered if patients still have symptoms such as heart failure due to myocardial ischemia and blockage of blood vessels. If the patient does not have the

appropriate symptoms, a non-invasive examination is recommended (for example, a strength test, a rest/stress echocardiography, a radionuclide study of the rest/stress heart, and so on.). Medications can be used for CTO lesion that has no evidence of myocardial viability or dominates the myocardium in small quantities.

CTO-PCI does not have a high success rate in the beginning, 50%-70% [9,10,18,19]. But with the development of modern equipment and technology [20-22], the profitability of CTO-PCI in many centers around the world has exceeded 80% [23-25] some centers can reach about 90%. The level of development of regional interventions in our country is uneven, and the popularity of new types of equipment is low. Objective factors to a certain extent hinder the process of CTO-PCI treatment standards in our country. Therefore, based on the integration of the clinical experience of our country and the analysis of relevant information and progress in research in this area, Chronic Total Occlusion Club Qazaq (Chronic Total Occlusion Club Qazaq, CTOCQ) developed a proposed method of interventional treatment of Coronary chronic total occlusion in Kazakhstan for reference to interventional doctors.

## **CTO-PCI technology, strategy overview and recommended way**

### **Detailed assessment of CTO-PCI lesion visualization (Imagine Science)**

Thorough and repeated vision of coronary angiography, which is the basis of interventional treatment of CTO lesions. Most CTO lesions require polygonal bilateral coronary angiography before interventional treatment. In case of CTO lesions with well-developed spontaneous collateral vessels during interventional treatment, it is recommended to perform bilateral coronary angiography or perform super selective contrast with independently developed collateral vessels in order to reduce lesion to the target blood vessels caused by the inserted contrast. Coronary CT angiography (CCTA) is recommended before repeating interventional treatment for CTO lesions that previously failed attempts or have complex anatomical structures (for example, severe curvature, abnormal hole origin, and total occlusion of the primary part).

The assessment of the visualization of the CTO lesion (Imagine Science) includes the anatomy of the nearest end of the CTO lesion (morphology of the displacement site, whether the occlusal end has large branched blood vessels), the vascular part of the CTO lesion (calcification, curvature, length of the occlusal segment) [26] and the far end of the CTO lesion (the form of a fibrous valve, does the far end of the occlusion have large branched blood vessels, or does the far end of the occlusion end in a bifurcated lesion, diffuse lesions in the occlusal segment and segment are there at the end of blood vessels in occlusal segment?). In addition, it is necessary to carefully assess the presence of collateral blood vessels that have an opposite entrance. attention should be paid to the way of development of collateral vessels of the opposite direction, the diameter of their width, the degree of curvature, the angle between the collateral blood vessels and the blood vessels of the donor /acceptor (host), the distance between the collateral blood vessels and the far end of the occlusion after entering the blood vessels of the acceptor, etc. [27-29] if collaterally donor blood vessels have lesion that can affect blood flow or acute occlusion, the lesion must first be treated before starting retrograde direction interventional treatment.

## **Strategic planning of CTO-PCI interventional therapy**

### **Initial statement of the CTO-PCI strategy**

(1) The initial strategy for defeating a CTO with a truncated trunk involves entering the standing side (antegrade). If there is an unspecified anatomical structure or an indistinct lesion of the SRT, if possible, intravascular ultrasound (intravascular ultrasound IVUS) interventional therapy can be performed.

(2) Antegrade dissection re-entry technique (ADR) [30-34] strategy: entry in the former antegrade direction in case of failure of interventional treatments, in poor condition of the branched (collateral) vessel or in the former retrograde direction (retrograde) interventional treatments were stepless and are used in occlusion in the occlusive segment and occlusive segment without diffuse lesions of blood vessels and in the landing zone, and the length of the occlusal segment is more than 20 mm

(3) For CTO lesions that are inconvenient for direct interventional treatment, direct retrograde direction interventional therapy can be used if there are effective collateral vessels in the opposite direction.

## **Strategy regulation in the CTO-PCI process**

(1) The key to adjusting the strategy in the CTO-PCI process is to change the strategy in a timely manner.

(2) If the direct guide wire(wire) cannot pass through the occlusion section, ADR technology or parallel guide wire technology can be considered. To improve the success rate of parallel guide wire technology, KDLC (Kaneka Corporation) or SASUKE (Asahi INTECC co., LTD.) a two-Lumen microcatheter can be considered as a parallel guide wire technology driven by a double-lumen microcatheter.

(3) However, if the distant blood vessels in the occlusal segment have significant diffusion lesion, the probability of success of parallel conductor technology and ADR technology is often low. In the presence of lateral blood vessels that are effective for use, direct retrograde direction interventional therapy can be used.

(4) Antegrade and retrograde directions combination technique (two-way preparation): It is difficult to succeed in complex CTO lesions, antegrade or retrograde directions strategies. After the entrance in the antegrade direction failed, the technique in the opposite direction should be picked up earlier or interventional treatment in the opposite direction should be carried out immediately [35]. In some cases, ADR technology can be used together.

## **Preoperative preparation of CTO-PCI**

The method of interventional therapy should be chosen based on factors such as the underlying condition of the patient, the habits of the surgeon, the methods and equipment used [36]. There is strong active support (backup) based on compliance prerequisites It is recommended to use the assessment catheter as much as possible. EBU (MEDTRONIC, INC) XB (CORDIS Corporation) AMPLATZ catheters and other guide catheters, it is recommended to use AMPLATZ XB RCA (CORDIS Corporation) and other guide catheters for the right coronary artery If you plan to implement IVUS guidance in real time, it is advisable to use at least 7F catheters for routing; if you plan to combine KDLC double lumen microcatheters and IVUS catheters, it is worth using 8F-guide catheters; If you cannot use 8F guide catheters, but cannot use double lumen microcatheters for interventional treatment with IVUS, you can choose SASUKE double lumen microcatheters or use the Ping-pang guide catheter method (ping-pang guide catheter technique); When operating ADR equipment, it is recommended to use 7 F / 8 F guide catheters. A guide catheter with lateral openings helps to reduce the probability of coronary artery lesion caused by coronary artery ischemia and contrast injection.

To prevent catheter thrombosis, regular use of conventional heparin for anticoagulation during the CTO-PCI process and constant monitoring during surgery (activated clotting time-ACT) is recommended. It is recommended to monitor once every 30-45 minutes to maintain the ACT at 250-350 °C

## **CTO-PCI technology**

### **Antegrade direction CTO-PCI technology**

(1) Selection and replacement of guide wires in the antegrade direction (Table 1): for the defeat of CTO with conoid tubercles, it is recommended to start with the design of a conoid head with a low and medium degree of polymer coating. If the primary guide wire cannot pass occlusal lesion, it is recommended to update the middle penetrating guide wire. If the aforementioned guide wire still cannot pass through the

Table 1

Frequently used guide wire by CTO-PCI

category	name	polymer coating	diameter of the cone end (in)	End stiffness (g)	country-manufacturer
degree of puncture low	Fielder XT	Y	0.009	0.8	Asahi Intecc
	Fielder XT-R	Y	0.010	0.6	Asahi Intecc
	Fielder XT-A	Y	0.010	1.0	Asahi Intecc
	Pilot 50	Y	N	1.5	Abbott Vascular
	Gaia First	N	0.010	1.7	Asahi Intecc
	Cross-it 100 XT	N	0.010	2.0	Abbott Vascular
degree of puncture medium	Pilot 150	Y	N	2.7	Abbott Vascular
	Pilot 200	Y	N	4.1	Abbott Vascular
	Miracle 3	N	N	3.0	Asahi Intecc
	Ultimate Bros 3	N	N	3.0	Asahi Intecc
	Gaia Second	N	0.011	3.5	Asahi Intecc
	Cross-it 200	N	0.011	3.0	Abbott Vascular
degree of puncture penetration	Conquest Pro	N	0.009	9.0	Asahi Intecc
	Conquest Pro 12	N	0.009	12.0	Asahi Intecc
	Gaia Third	N	0.012	4.5	Asahi Intecc
	Progress 200T	N	0.009	13.0	Abbott Vascular
	Miracle 12	N	N	12.0	Asahi Intecc
	Conquest Pro 8-20	N	0.008	20.0	Asahi Intecc

Note: CTO, chronic total occlusion; PCI, Percutaneous Coronary Intervention; 1 in = 2,54 cm

occlusive disease, it can be upgraded to a guide wire that enters upwards. In case of CTO lesion, in which the eye is not clearly visible, for example, the presence of vessels of the corresponding branch at the proximal end of occlusion, IVUS visualization is recommended for the direction of proximal puncture of the fibrous cover. A medium penetration guide wire can be used first, if it fails, it is recommended to use a high penetration guide wire. After the conductive wire with high permeability passes through the proximal fibrous coating, if the occlusion segment is long or the way is unclear, it can be replaced with a medium penetrating guide wire (step Down), in some cases, when this conductive wire enters the distal fibrous coating, it is necessary to use a high-penetrating guide wire (step up) with good processing ability. Gaia series (ASAHI INTECC CO. LTD.) for solid calcifications, twists and occlusive lesions with a long segment. Use the guide wire with caution.

(2) Antegrade direction guide wire technique: When intervening in the antegrade direction, if the occlusal segment is short, it is recommended to first use the technique of moving the guide wire up its own ladder. If the occlusal segment is long or the technique of replacing the guide wire failed, in addition, the distal blood vessels of the occlusal segment do not have diffuse disease, and the landing zone does not contain large branched vessels, ADR technology [based on Crossboss (Boston Scientific Corporation) Stingray (Boston Scientific Corporation)balloon [30-31] or technology of entry from the false lumen based on the guide wire into the true lumen [32-34] should be considered.. In some cases, within the framework of IVUS, a guide wire can be inserted from a false lumen into a true one [37]. If you cannot perform ADR technology, try using parallel guide wire technology or retrograde guide wire technology. when the antegrade pointing wiring technique fails, it is recommended to start the retrograde-direction intervention therapy as early as possible, if there are available branched vessels (Collateral circulation).

(3) The way to solve problems, when the guide wire prevents the passage of the equipment (instrument) through the lesion, the CTO / balloon cannot rise: if the equipment is difficult to deliver forward, after confirming that the guide wire is in the true lumen of the remote vessel, the technology of deep intake of the guide catheter, Balloon anchoring technology (when there is a large branch nearby), Buddy wire guide technology [38]

Baby and mother catheter technology,GUIDEZILLA catheter technology (Boston Scientific Corporation)The TORNUS catheter (ASAHI INTECC Co., LTD.) [39] To expand occlusal lesion, it is necessary to use a thin balloon with a width of 1 mm and a length of 20 mm, an excimer laser, coronary drilling (Rotablator) and other methods. If it is not possible to expand the balloon, you can use the technology of double balloon - staggered cutting guide wire (double balloon-staggered cutting guide wire), two guide wire technology of alternating with one balloon, Tornus catheter, excimer laser, Rotablator and other methods.

## Retrograde direction CTO-PCI technology

(1) Selection and manipulation of retrograde direction guide wire: selection of Collateral circulation. In retrograde direction interventional therapy, septal vessels are usually slightly analyzed, but well-developed epicardial collateral vessels can also be used with caution. Some patients after coronary artery shunt surgery may use a vessel shunt. ②selection of the guide wire passing through the collateral vessels (Table 2), Usually, the wire is chosen soft, well-sensitive to the hand when inserted, a guide wire, convenient for passing through the curved part. Representative guide wire - Sion (ASAHI INTECC Co., LTD.). Fielder X TR (ASAHI INTECC CO., LTD.) should be used if the collateral vessels (Collateral circulation) are strongly curved and the Sion guide wire cannot pass and if the internal lumen of the blood vessel is thin. Try using a guide wire, but the surgeon should be careful, it is advisable to be careful not to get into an invisible branch. If the circle of collateral vessels is large, Sion Black (ASAHI INTECC CO., LTD.) guide wire can be used. For very strongly curved collateral vessels (collateral vessels such as fast noodles), SUOH 03 (ASAHI INTECC CO., LTD.) guide wire is recommended. After penetration into the lateral Vessel, the shape of the guide wire end should be as short as possible, usually less than 1 mm or 1 mm, with an angle from 70° to 90°. The main method is to conduct a guide wire from the collateral vessel by twisting. do not press hard so as not to lesion the collateral vessel. Some methods of surfing from the Septal collateral vessel [40] can be carried out using a guide wire, but cannot be applied to epicardial collateral vessels. In order not to lesion the collateral vessel, the surgeon should insert a guide wire against the background of highly intelligent angiography.

**Table 2** Frequently used guide wire by CTO-PCI

Anatomical features	Intermediate branches	Collateral vessels of the epicardium,
continuous curving	Sion SUOH 03 Fielder XT-R	Sion SUON 03 Fielder XT-R(Small blood vessels) Sion black(Big vessels)
Blood vessel a branch from a crooked place,	Sion SUON 03 Fielder XT-R(Small blood vessels) Sion black(Big vessels)	SUON 03 Sion Fielder XT-R(Small blood vessels) Sion black(Big vessels)
sharp angle,	SUON 03 Sion Sion black	SUON 03 Sion Sion black
invisible collateral channels	Sion Sion black Fielder XT-R	Avoid actions

Before performing a superselective angiography, the surgeon should try to pump blood from the microcatheter so as not to lesion the guaranteed vessels. ③restoration of collateral vessel lesion. Most of the septal collateral vessel is damaged without serious consequences, requires only a thorough examination. In some patients, after lesion to septic vessels, a large hematoma or perforation occurs, which can lead to hemodynamic instability. Regular, embolization and symptomatic treatment should be carried out on time

When the collateral vessels of the epicardium are damaged, this often leads to tamponade of the heart. The surgeon must actively fight it and carry out embolization on time. If the CTO lesion is opened, the surgeon must not only embolize the donor collateral vessel, but also embolize the target CTO in the opened vessel. If some collateral vessel is damaged, the microcatheter can be stopped by negative pressure, prolonged suction back. Selection of guide wires after passing the collateral vessel. In accordance with the morphology of the distal fibrous valve, which is indicated by super selective angiography, it is recommended to choose different guide wires. If the cover of the distal fiber of the CTO lesion has a conical shape, it is preferable to use a guide wire with low or medium penetration; if there is no end at the end of the distal fibrous cap or the guide wire specified above cannot pass through the distal fibrous cap, it is recommended to replace the guide wire that enters the medium/high.

(2) Selection of microcatheter: Corsair (ASAHI INTECC CO, LTD.) Finecross (Terumo corporation) and etc. choose a microcatheter with a length of 150 cm, in some cases, a 90 cm long guide catheter is required if the developed interval of the collateral vessel is at a great distance. If the Corsair microcatheter cannot pass through the collaterals, you can use the Finecross microcatheter; you can replace the new Corsair microcatheter; Use the Caravel 150 cm microcatheter (ASAHI INTECC CO., LTD. ) or Corsair Pro microcatheters (ASAHI INTECC CO., LTD.); balloon attachment technology; Combined use of Guidezilla catheters, etc.; expansion of the septal collateral vessel with a small balloon under low pressure [1,0-1,25 mm, 2-4 atm (1 atm = 101,325 kPa)], but the collateral vessel of the epicardium cannot be used; Use a Threader Catheter (Boston Scientific Corporation); In some cases, you can first use the Corsair 135 cm microcatheter, and then switch to the Corsair 150 cm catheter. If none of the above methods gives results, it is recommended to analyze another collateral vessel in time or continue in the antegrade direction, standing on the retrograde direction of the guide wire.

(3) Commonly used retrograde guide wire technology:the technology of the guide wire in the retrograde direction mainly includes the technology of conducting wiring in the retrograde, the technology of docking the wire in the retrograde, antegrade directions, the technology of tracking the path through the inner curtain (controlled antegrade and retrograde directions subintimal tracking, CART) with controlling of the guide wire in the retrograde and antegrade directions [41], retrograde direction CART technology. the technology of guide wiring in the retrograde, the technology of connecting guide wiring in the retrograde and antegrade directions are mainly suitable for cases when the length of the damaged part of the CTO is shorter. In case of failure, it is recommended to use retrograde direction CART technology as soon as possible. If it is expected that the distance between the damaged parts of the CTO will be long, curved, the anatomy of the damaged part will be difficult, the chances of success of the guide wire wiring technology in the retrograde, wire docking techniques in the opposite direction will be low. To increase the efficiency and success of the operation, it is recommended to perform the retrograde direction CART technology as soon as possible. With curved, calcified injuries, the usual way of working with wire can puncture blood vessels, if necessary, Knuckle technology can be used. If retrograde direction CART technology fails, consider retrograde direction CART technology within IVUS [42].

(4) The output of the guide wire outside the bode frame : Currently, a 330 cm Rg3 guide wire is recommended for output outside the body frame (ASAHI INTECC CO.), LTD.). If the retrograde direction guide wire is difficult to insert directly into the guide catheter, or if the direction microcatheter cannot be inserted directly into the guide catheter, it is recommended to use the active greeting technique as soon as possible (active greeting technique, AGT, that is, the Guidezilla catheter, the mother and child catheters have a retrograde direction guide wire that opposes the antegrade guide catheter). In some cases (for example, total occlusion of the initial part of the right coronary artery, total occlusion of the initial part of the left coronary artery, etc.), through a special trap or a homemade trap, you can catch the return guide wire and pull it out of the body frame [21]. During interventional treatment and when removing the RG3 guide wire, it is necessary to cover the microcatheter with the collateral vessel as much as possible in order to prevent the cutting of the guide wire by the collateral vessel, as well as to prevent lesion to the mouth of the coronary artery by the guide catheter in the retrograde. If there is no RG3 guide wire, you can

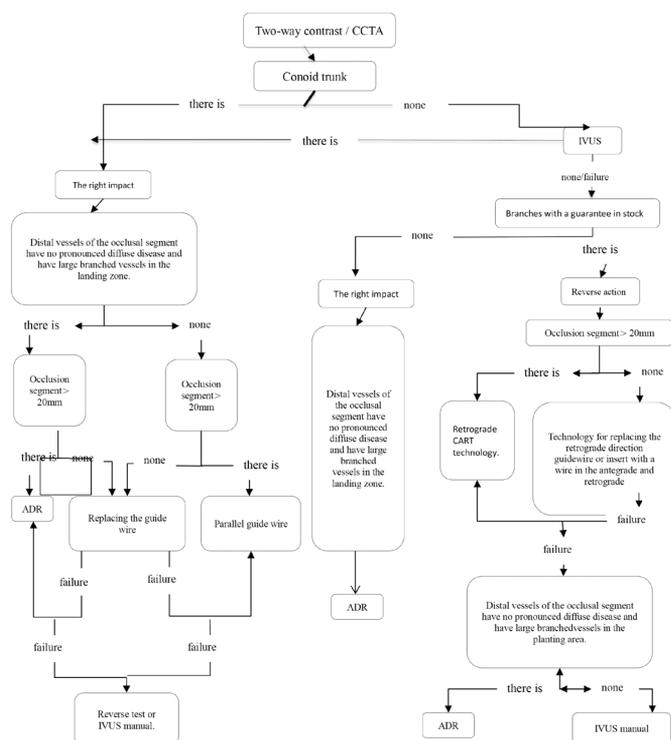
use another 300-330 cm guide wire (but the drilling guide wire or extension guide wire should be avoided), as well as Rendezvous technology (such as microcatheter docking technology) and its advanced technique to complete the PCI operation [43].

## Recommended CTOCC CTO -PCI way (Figure 1)

Way 1: In the case of lesions of the CTO with conoid trunks, the initial strategy provides for interventional therapy.

Way 2: The 1st way does not have a severe degree in blood vessels exceeding the occluded segment. If the length of the occlusal segment is greater than 20 mm, ADR technique should be used first, and if the occlusal segment is shorter than 20 mm, interventional therapy should be analyzed first and the guide wire replacement technique should be applied. If the guide wire replacement technique fails, use the ADR technique to unlock the lesion.

Figure 1 - Proposed road scheme of CTOCC CTO-PCI



Note: CTO, chronic total occlusion; PCI, Percutaneous Coronary Intervention; CCTA, coronary CT angiography; ADR, Antegrade dissection re-entry technology; IVUS, intravascular ultrasound ; retrograde direction CART technology, the technology of finding the antegrade and retrograde directions subintimal path through the control in the opposite direction.

Way 3: If in way 1 there are severe diffuse lesions of the distal vessels of the occlusal segment and / or CTO lesions involving large branched vessels in the landing zone, the length of the occlusal segment is more than 20 mm, analyze antegrade direction interventional therapy and first try parallel guide wires: If the length of the occlusal segment is less than 20 mm, then first you should use the technique of replacing the guide wire. If the guide wire replacement technique failed, you can use the parallel guide wire technique to uncover the lesion.

Way 4: In case of CTO lesions that were not successful by the methods proposed in ways 1-3, retrograde direction interventional therapy or antegrade direction interventional therapy against the background of IVUS is recommended.

Way 5: If the CTO is affected without a cut arc, if possible, it is recommended to use the methods proposed in the ways below 1 to 4 recommended by IVUS.

Way 6: In case of failure to open the lesion to the CTO without a conoid trunk, not equipped with IVUS equipment or the proposed technology of the 5th way, if the collateral vessels are not suitable for use, antegrade direction interventional therapy is recommended. In the event that there are no severe diffuse lesions in the distal vessels of the occlusive segment and/or there is a CTO lesion that does not affect a large branched vessel in the landing zone, it is recommended to use ADR technology in antegrade direction interventional therapy.

Way 7: In case of failure to open the lesion to the SRT without a conoid trunk, not equipped with IVUS equipment or the proposed technology of the 5th way, in the presence of collateral vessels suitable for use, retrograde direction interventional therapy is recommended.

Way 8: In way 7, for lesion of the CTO with an occlusal segment length of more than 20 mm, it is recommended to use first the retrograde direction CART technique during retrograde direction intervention; for lesion of CTO with an occlusal segment length of less than 20 mm, you can use the technology of replacing wires in the retrograde direction or docking antegrade and retrograde directions guide wires. If the above method fails, try the retrograde direction CART technique to unlock the lesion.

Way 9: For a CTO lesion that was not successful with the technique proposed in way 8, if there are no severe diffuse lesions in the distal vessels of the occlusal segment and/or there is lesion to the CTO that did not affected the large branched vessel in the landing zone, ADR technology is recommended: if severe diffuse lesions and/or CTO lesions involving large branched vessels in the landing zone are observed in the distal vessels of the occlusal segment, antegrade direction interventional therapy against IVUS is recommended.

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