16 CHRONIC TOTAL OCCLUSION

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CORONARY ARTERY OCCLUSION

PTCA of chronic total occlusions represents 10-20% of all angioplasty procedures and poses a management dilemma for the interventional cardiologist. Although collaterals maintain myocardial viability under resting conditions, they often fail to provide sufficient blood flow during periods of increased oxygen demand, resulting in lifestyle-limiting angina. Successful revascularization improves anginal status, increases exercise capacity, and reduces the need for late bypass surgery. However, PTCA of a chronic total occlusion is associated with lower success rates, higher equipment costs, increased radiation exposure, and more restenosis compared to PTCA of nontotal occlusions. Improved guidelines for case selection, new interventional devices, and adjunctive pharmacotherapy may favorably impact these patients.

A. PATHOPHYSIOLOGY (Table 16.1). The success of percutaneous techniques for revascularization of total occlusions is determined by the clinical presentation, presence of collaterals, and morphology of the obstruction, which vary between acute and chronic total occlusion.

1. **Acute Occlusion.** These patients frequently present with acute myocardial infarction and absent or poorly developed collaterals. Unless coronary flow is restored within 4-6 hours, myocardial injury is permanent. Pathologically, the obstructed lumen typically consists of ruptured plaque and fresh clot. These types of acute occlusions are readily crossed with conventional guidewires, accounting for procedural success rates exceeding 90%. The likelihood of successful recanalization decreases over the ensuing months as fresh thrombus undergoes organization, fibrosis, and calcification.

2. **Chronic Total Occlusion.** These patients frequently present with a change in anginal status rather than acute MI. Well-developed collaterals may provide flow equivalent to a 90-95% stenosis, which helps maintain myocardial viability and prevents resting myocardial ischemia.[1] Overall contractile function may be normal, or a regional wall-motion abnormality may be present due to hibernating myocardium or non-Q-wave MI. Pathologically, the major constituent of a chronic total occlusion is fibrocalcific plaque.[112] These obstructions are often resistant to guidewire crossing, accounting for lower success rates compared to nontotal occlusions.

Table 16.1. Total Coronary Occlusion: Clinical and Pathological Features

	Acute Occlusion	Chronic Occlusion
Presentation	Acute MI	Change in anginal status; angina is usually exertional (collateral insufficiency)
Histopathology	Ruptured fibrous cap overlies soft atheroma; acute occlusive thrombus is common	Complex fibrocalcific atherosclerosis with chronic organized thrombus
Spontaneous recanalization	Occasional	Rare
Collaterals		
Intracoronary	Rare	Occasional (bridging collaterals)
Intercoronary	Less common	Common
Myocardial viability	Uncommon unless collaterals are present	Collaterals sustain viability; wall motion may be normal
PTCA success	High	Variable; depends on duration and morphology

B. INDICATIONS AND BENEFITS OF PERCUTANEOUS REVASCULARIZATION (Table 16.2).

C. BALLOON ANGIOPLASTY

1. **Procedural Outcome.** Compared to PTCA of nontotal occlusions, revascularization rates for chronic total occlusions remain disappointingly low (Table 16.3). Older series comprising more than 4400 total coronary occlusions indicate an overall success rate of 69% (range 47-81%) (Table 16.4). The most common reasons for procedural failure included the inability to cross the occlusion with a guidewire (80%), failure to cross the occlusion with a balloon (15%), and failure to dilate the stenosis (5%). The recent availability of several varieties of hydrophilic guidewires has improved failure to traverse total occlusions, and use of the Rotablator has decreased procedural failures due to lesion rigidity.

2. **Predictors of Success.** Case selection remains the single most important predictor of PTCA success. Depending on the presence of clinical and angiographic variables, recanalization rates range from 18-87% (Tables 16.5-16.7, Figure 16.1):
   a. **Complete vs. Functional Occlusion.** Pooled data indicate that functional occlusions (99% stenosis with delayed incomplete opacification of the distal vessel segment) are more often recanalized than complete occlusions (76% vs. 67%). It is essential to differentiate the true lumen of a functional occlusion from the perivascular channel of a bridging collateral; the former is a predictor of PTCA success, while the latter predicts PTCA failure. This distinction can usually be made by obtaining multiple angiographic projections of the occlusion, but sometimes is not apparent until attempts are made to cross the occlusion with a guidewire.

Table 16.2. Chronic Total Occlusion: Indications and Benefits of Revascularization

Indications
- Medically refractory angina
- Large area of ischemia by noninvasive studies
- Favorable angiographic appearance

Proven Benefits
- Relief of exertional angina
- Improvement in global and regional left ventricular function and exercise capacity[27,114,115,116,117]
- Reduction in the need for late CABG by 50%

Possible Benefits
- Potential source of collaterals to other vessels
- Improvement in left ventricular remodeling following MI[114]
- Improvement in event-free survival

b. **Duration of Occlusion.** The duration of occlusion is estimated as the time interval between a major ischemic event (Q-wave MI, new onset angina, abrupt worsening in anginal status) and PTCA. Successful revascularization is highest for occlusions < 1 week, intermediate for occlusions 2-12 weeks, and lowest for occlusions > 3 months. Occlusion duration alone should not preclude revascularization since procedural success for occlusions > 6 months may be as high as 50-75%.[8,12]

c. **Length of Occlusion.** While it is generally felt that occlusion lengths > 15 mm are associated with lower success rates, this characteristic alone should not preclude PTCA.

d. **Sidebranch at Point of Occlusion.** This occlusion characteristic is associated with reduced success due to the tendency of the guidewire to pass into the sidebranch.

e. **Presence of a Tapered Stump.** Funnel-shaped or tapered occlusions are associated with higher recanalization rates than occlusions with abrupt cutoffs. Tapered occlusions frequently contain small recanalized channels that escape detection by angiography but provide a potential route for successful guidewire passage.[80,112]

f. **Intracoronary "Bridging" Collaterals.** Most angioplasty series suggested that the presence of bridging collaterals was the single most important determinant of failed PTCA for chronic total occlusions. However, Kinoshita et al [9] reported equally high success rates for total occlusions with (n = 109) and without (n = 324) bridging collaterals (75% vs. 83%, p = 0.07). The authors attributed the high success rate to operator experience and aggressive use of stiff wires. Our own experience suggests that when faint bridging collaterals coexist with one or more favorable characteristics (e.g., tapered stump, short segment of occlusion), success rates may exceed 50%. However, occlusions that are associated with extensive bridging collaterals ("caput medusa") are generally considered unsuitable for PTCA due to extremely low success rates (< 20%). These networks of vessels consist of dilated vasa vasorum and neovascular channels and are very fragile and susceptible to perforation during crossing attempts.

Table 16.3. PTCA of Nontotal vs. Chronic Total Occlusion: Acute Outcome

Series	Group+	N	Success (%)	Complications (%) D / MI / CABG
Berger[30]* (1996)	Nontotal	1295	-	0 / 1.4 / 0
	Total	139	-	0 / 1.5 / 0.3
Jaup[125]** (1995)	Nontotal	280	84	0 / 2.1 / 0.9
	Functional	67	75	1.5 / 0 / 0
	Total	453	67	2.5 / 1.0 / 1.1
Favereau[2] (1995)	Nontotal	2065	96	1.4
	Total	292	67	1.7
Tan[3] (1995)	Nontotal	1157	93	0.4 / 0.7 / 2.1
	Total	91	66	0 / 0 / 0
Ruocco[4] (1992)	Nontotal	1429	82	0.7 / 4.8 / 3.5
	Total	271	59	1.8 / 3.6 / 3.3
Myler[5] (1992)	Nontotal	779	94	1.7
	Total	122	76	1.6
Plante[6] (1991)	Nontotal			
	Stable Angina	637	-	4
	Unstable Angina	442	-	8
	Total			
	Stable Angina	44	48	2.5
	Unstable Angina	46	65	2.0
Stone[7] (1990)	Nontotal	6950	96	0.9 / 1.5 / 1.7
	Total	905	72	0.8 / 0.6 / 0.8
Safian[8] (1988)	Nontotal	711	90	0.4 / 3 / 2
	Functional	102	78	1 / 3 / 3
	Total	169	63	0 / 0 / 2

Abbreviations: D = in-hospital death; CABG = emergency coronary artery bypass surgery; MI = in-hospital myocardial infarction; - = not reported

\+ Functional total occlusion = 99% stenosis (TIMI flow = 1)
Nontotal occlusion = 51-99% stenosis (TIMI flow $\geq$ 2)
Total occlusion = 100% stenosis (TIMI flow = 0);

* In-hospital complication rate among successfully dilated occlusions

** Magnum wire

g. **Other Factors**. Other factors variably associated with lower success rates include lesion calcification, proximal vessel tortuosity, distal location, RCA or circumflex occlusion, diffuse proximal disease, multivessel disease, and unstable angina.[7,14,15,18,19] However, none of these factors are considered significant contraindications to PTCA in the hands of experienced operators.

Table 16.4. PTCA of Chronic Total Occlusion: Acute Outcome

Series	N	Success (%)	Complications (%) D / Q-MI / CABG
Olivari[142] (2002)	458	77	2.5
Noguchi[127] (2000)	226	59	- / 1.3 / -
Nobuyoshi[119] (1998)	1138	63	- / - / -
Berger[30] (1996)	139	-	0 / 1.4 / 2.9
Favereau[2] (1995)	367	67	1.7
Jaup[125] (1995)	453	67	2.5 / 1.0 / 1.1
Kinoshita[9] (1995)	433	81	0.3 / 0 / 0
Ishizaku[10] (1994)	111	62	0 / 1.6 / 0
Tan[11] (1993)	312	61	0.3 / - / 1.6
Shimizu[12] (1993)	468	75	- / - / -
Maiello[14] (1992)	365	64	0 / 0.6 / 0.3
Myler[5] (1992)	122	76	1.6
Ivanhoe[15] (1992)	480	66	1 / 2 / -
Ruocco[4] (1992)	271	59	2 / 1 / 2
Bell[16] (1991)	354	66	0.3 / 1.7 / 2.5
Stone[7] (1990)	971	72	0.8 / 0.6 / 0.8

Abbreviations: D = death, Q-MI = Q-wave myocardial infarction, CABG = emergency coronary artery bypass grafting; - = not reported

Table 16.5. Chronic Total Occlusion: Predictors of PTCA Outcome

Procedural Success	Procedural Failure
Functional occlusion	Total occlusion
Occlusion age < 12 weeks	Occlusion age > 12 weeks
Length < 15 mm	Length > 15 mm
Tapered stump	Abrupt cut-off
No sidebranch at point of occlusion	Sidebranch present
No bridging collaterals	Extensive bridging collaterals ("Caput Medusa")

3. **Complications.** Although PTCA of a chronic total occlusion is generally considered a "low-risk" procedure, the incidence of major complications is similar to nontotal occlusions, and the presence of a chronic total occlusion is an independent predictor of acute closure.[20,21] Major complications include acute closure (5-10%), MI (0-2%), emergency CABG (0-3%), and death (0-1%) (Table 16.4). In one report,[2] reocclusion within 24 hours of successful PTCA occurred in 8% of total occlusions compared to 1.8% of nontotal occlusions. Reocclusion was silent in 87%. In another study of chronic total occlusion, complications after PTCA occurred in 20% of patients who presented with unstable angina compared to 2.5% in those with stable angina.[6] Ischemic complications are usually due to dissection, thrombus, distal embolization, or damage to collaterals. Less common complications include coronary artery perforation[51] (relative risk 3.1[13]), reperfusion arrhythmias (including rare delayed ventricular fibrillation),[23] and guidewire entrapment and fracture. Acute reocclusion may cause ST-segment elevation and hemodynamic deterioration due to delayed recruitment of previously functioning collaterals.

4. **Late Outcome**
   a. **Anginal Status and Exercise Capacity (Table 16.7).** The majority of patients with successful PTCA are asymptomatic at follow-up. In the three largest reports, 70% of patients were asymptomatic 1-4 years after PTCA.[4,15,24] Absence of symptoms does not exclude restenosis, since 40% of patients with restenosis may be free of chest pain.[25]

   b. **Ventricular Function.** Although data are limited, successful PTCA may improve ventricular relaxation and regional wall motion.[19,26] Global ejection fraction improved in some studies,[27,114-117] but not in another.[28] Among patients with successfully recanalized occlusions, those with persistent patency and normal flow had better global function and less ventricular dilatation than patients without patent vessels.[29]

   c. **Death, MI, CABG (Tables 16.9, 16.10).** Most studies indicate that successful recanalization of a chronic total occlusion reduces the need for CABG by 50-75%. However, PTCA does not improve survival or reduce the incidence of late MI.

Table 16.6. Impact of Occlusion Duration on PTCA Outcome

Series	Occlusion Duration	N	Success (%)
Tan[3]	< 3 months	42	76
(1995)	> 3 months	49	57
Ishizaku[10]	< 1 month	11	91
(1994)	> 1 month	100	56
Myler[5]	< 1 week	99	87
(1992)	1-12 weeks	73	88
	> 3 months	49	59
Bell[16]	< 1 week	60	74
(1992)	1-4 weeks	15	93
	1-3 months	243	67
	> 3 months	45	64
Maiello[14]	< 1 month	73	89
(1992)	1-3 months	77	87
	> 3 months	110	45
Stone[7]	< 12 weeks	29	90
(1990)	> 12 weeks	39	74

d. **Restenosis (Table 16.11).** Restenosis and complete reocclusion are very common after PTCA, with rates of 40-75% and 11-34%, respectively. Observational and randomized trials of stents vs. PTCA indicate less restenosis and target lesion revascularization with stents (Tables 16.14, 16.18).

D. EQUIPMENT SELECTION AND PTCA TECHNIQUE. PTCA of a chronic total occlusion can be technically challenging and, compared to PTCA of nontotal occlusions, is associated with more procedural time, increased cost (due to use of more guiding catheters, guidewires, and balloons), and more radiation exposure to the patient and operator (Table 16.12). Improvements in equipment have improved success and reduced complications, particularly with regard to the availability of hydrophilic guidewires.

1. **Guiding Catheter.** It is essential to use a guiding catheter that provides good back-up support and coaxial alignment. For chronic total occlusions in native coronary arteries, a geometric or left Amplatz guide will provide excellent support. If a Judkins or Multipurpose guiding catheter is used, the "deep-seating" maneuver may be employed to provide extra back-up (Chapter 11). Deep catheter intubation from the left brachial approach may enhance support when PTCA from the femoral approach proves unsuccessful, but is rarely necessary. Occasionally, another catheter placed in the contralateral coronary artery to image the collateral flow to the occluded vessel may facilitate recanalization.

Table 16.7. Impact of Occlusion Characteristics on PTCA Outcome

	Success (%)			
Series	**Length Short / Long**	**Occlusion Type Functional+ / Total++**	**Tapered Stump Yes / No**	**Bridging Collaterals Yes / No**
Noguchi[127] (2000)	67 / 40	-	-	-
Mousa[93**] (1998)	-	96 / 95	-	-
Schofer[96***] (1998)	68 / 25	-	-	-
Kinoshita[9] (1995)	-	-	-	75 / 83
Tan[11] (1993)	-	-	69 / 43	70 / 20
Maiello[14*] (1992)	71 / 60	68 / 69	83 / 51	67 / 29
Ivanhoe[15] (1992)	-	78 / 60	73 / 60	-
Stone[7] (1990)	85 / 69	83 / 74	88 / 59	18 / 85

* Success rate with/without sidebranch at occlusion site (61% vs. 69%)
\+ Functional occlusion = faint, late antegrade filling beyond the lesion
++ Total occlusion = absence of antegrade filling beyond the lesion
** Stent trial (after guidewire crossing)
*** Laser guidewire
\- Not reported

2. Guidewires

a. Conventional Angioplasty Wires. Serial use of progressively stiffer but flexible guidewires is a popular approach to crossing a chronic total occlusion. Some operators prefer to begin with stiff wires or glidewires, since soft-tip wires will successfully cross only 30-50% of occlusions. We frequently begin with a 0.018" gold-tip angled Glidewire, and exchange for a flexible 0.014" wire after crossing the occlusion. We avoid monorail systems for total occlusions because of inferior balloon tracking and the inability to readily exchange the guidewire. If collaterals are present, a late freeze-frame image can be used to estimate the length of the occlusion, identify the distal vessel, and help direct the guidewire through the expected lumen.[35] Extra support for the guidewire can be achieved by trailing the balloon catheter or a less expensive transfer catheter 1-2 cm behind the tip of the guidewire.

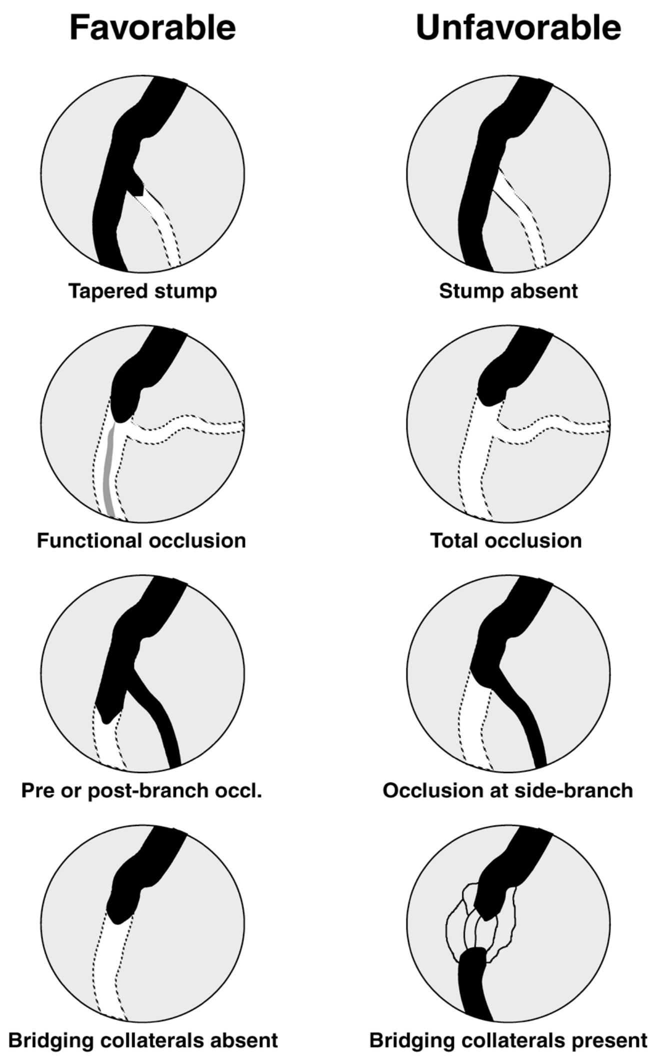

Figure 16.1. Chronic Total Occlusion: Lesion Morphology and Procedural Success

Table 16.8. Chronic Total Occlusion: Symptom Status After Percutaneous Revascularization

Series	Device	N	Follow-up (months)	Asymptomatic (%)
Olivari[142] (2002)	PTCA	Successful - 334+ Unsuccessful - 98	12 12	87++ 74++
Sirnes[97] (1998)	Stent PTCA	59 57	6 6	57 24
Suttorp[95] (1998)	Stent	38	6	84
Berger[30] (1996)	PTCA	139	6	87*
Stewart[13] (1993)	PTCA	45	12	68*
Ivanhoe[15]** (1992)	PTCA	264	36	69
Ruocco[4]† (1992)	PTCA	160	24	69
Bell[16]†† (1991)	PTCA	234	32	76

\+ Stents in 88%
++ Symptomatic status among patients without MI, TLR, or CABG
* Asymptomatic or Class I
** Successful vs. unsuccessful PTCA: 4-year freedom from death (99% vs. 96%), death or MI (93% vs. 89%), CABG (87% vs. 64%)
† 2-year death rate in successful vs. unsuccessful PTCA groups (1.2% vs 14.3%)
†† Less need for CABG after successful PTCA. No differences in MI, death, or severe angina between successful and unsuccessful PTCA

The Ultrafuse-X catheter (Boston Scientific Scimed) is well-suited for this purpose since it allows distal contrast injection without relinquishing guidewire position. Excessive guidewire rotation should be avoided during crossing attempts to prevent tip fracture. If the guidewire buckles, it should be retracted and reoriented rather than forced into the occlusion. Once the wire crosses the occlusion, intraluminal position should be confirmed prior to balloon inflation. Clues to proper guidewire position include free guidewire rotation and easy advancement and retraction of the guidewire. Confirmation of intraluminal positioning is aided by contrast injection through the guiding catheter, central lumen of the balloon, or transfer catheter positioned distal to the occlusion. Clues to improper guidewire position include loss of free rotation, inability to advance the guidewire beyond the occlusion, or inability to advance a balloon or transport catheter through the occlusion. If these latter conditions are observed, the wire may be subintimal or in a small bridging collateral outside the lumen. In any case, balloon inflation should not be performed due to increased risk of dissection and vessel perforation.

Table 16.9. PCI of Nontotal vs. Chronic Total Occlusion: Long-Term Outcome

Series	Occlusion Type	F/U (months)	Death (%)	MI (%)	CABG (%)	PTCA (%)	Combined Event (%)
Mousa[93]	Total (stent)	8	1	3.2	5.4	15	25
(1998)	Nontotal (stent)		2.9	2.4	4.1	14	23
Elezi[98]	Total (stent)	12	-	6.1†	1.5	31	36*
(1998)	Nontotal (stent)		-	4.1†	1.8	18	23
Berger[30]	Total (PTCA)	6	1.4	2.9	-	-	21+
(1996)	Nontotal (PTCA)		0.5	2.4	-	-	18
Violaris[31]	Total (PTCA)	6	0	3.6	3.6	21	29*
(1995)	Nontotal (PTCA)		0.2	2.8	2.4	17	22
Ruocco[4]	Total (PTCA)	2	††	5	19	9*	25+
(1992)	Nontotal (PTCA)			9	15	20	30
Safian[8]	Total (PTCA)	2	-	-	14*	-	41
(1988)	Nontotal (PTCA)		-	-	8	-	28

Abbreviations: CABG = coronary artery bypass grafting; MI = myocardial infarction; PCI = percutaneous coronary intervention; PTCA = percutaneous transluminal coronary angioplasty; F/U = follow-up; - = not reported

† Combined death/MI

†† Relative risk compared to nontotal occlusion (4.39); late death for successful vs. failed PTCA of total occlusion (9% vs. 14%, $p < 0.05$)

* $p < 0.05$

\+ CABG or PTCA

b. **Hydrophilic Guidewires.** The Glidewire and other hydrophilic guidewires[121,122,123] have been successfully employed for peripheral and coronary angioplasty and are popular because of their flexibility, kink-resistance, and lubriciousness. Small series suggest that the Glidewire may successfully cross 30-60% of occlusions that cannot be crossed with conventional guidewires (Table 16.3),[36-38] which is probably true of other hydrophilic guidewires from many manufacturers (Chapter 1).

c. **Magnum-Meier™ Recanalization Wire.** This ball-tipped guidewire consists of a 0.014", 0.018", or 0.021" solid-steel wire shaft, a flexible distal spring wire comprised of Teflonized® tungsten, and a 1-mm olive-shaped tip (Figure 16.2). The wire has been designed to increase pushability and reduce subintimal wire passage. The Magnarail balloon (monorail design) and Magnum-Meier over-the-wire balloon are currently the only commercially available balloons able to accommodate 0.021" wires. Results from observational studies and randomized trials have not demonstrated clear superiority over conventional PTCA guidewires.[25,39,124-126]

Table 16.10. Impact of Successful vs. Unsuccessful Revascularization of Chronic Total Occlusion on Long-Term Clinical Outcome

Series	Immediate Result	F/U (months)	Death (%)	MI (%)	CABG (%)	PTCA (%)	Combined Event (%)
Olivari[142] (2002)	Successful Unsuccessful	12	1.2 2.6	1.2 -	1.8* 15.8*	9.6 10.5	14.4 28.9
Naguchi[127] (2000)	Successful (PTCA) Unsuccessful (PTCA)	51	5 16	- -	7 (11 yrs) 27*	- -	- -
Dzavik[140] (2000)	Successful (stent) Unsuccessful (stent)	12-36	- -	- -	- -	- -	37 73
Stewart[13] (1993)	Successful (PTCA) Unsuccessful (PTCA)	12	2.2 4.1	- -	16* 45	13 16	31* 64
Ivanhoe[15] (1992)	Successful (PTCA) Unsuccessful (PTCA)	4	- -	- -	13* 36	- -	7^{++}* 11
Bell[16] (1991)	Successful (PTCA) Unsuccessful (PTCA)	5-7	18 25	11 5	18* 58	- -	- -

Abbreviations: CABG = coronary artery bypass grafting; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; F/U = follow-up; - = not reported

* $p < 0.05$

++ Death or MI

3. **Balloon Dilatation Catheter**

   a. **Over-The-Wire Systems.** Although a variety of low-profile on-the-wire and monorail balloon catheters are available, an over-the-wire system is preferred because it allows guidewire exchanges, balloon upsizing, and enhanced trackability. If difficulty is encountered advancing the balloon into the occlusion, maneuvers to increase guiding catheter support may be of value. Constant forward pressure on the balloon is generally more successful than aggressive tapping of the balloon against the occlusion ("jack-hammering"), which usually does not transmit additional force. If the reference vessel diameter cannot be estimated, the vessel should be predilated with a 1.5 or 2.0 mm balloon. If the reference vessel diameter is easily estimated (because of collateral filling of the distal vessel), a full-sized balloon may be used. For heavily calcified occlusions, high-pressure balloons may be preferred, but there is otherwise no specific advantage to any balloon material. The Rotablator is an important adjunct if lesion rigidity precludes balloon advancement; guidewire position in the true lumen must be ensured prior to burr activation.

   b. **Fixed Wire-Balloon Systems.** Balloon-on-the-wire catheters are generally not considered first-line systems due to their lack of pushability, trackability, and steerability. However, because of their extremely low profile, they may occasionally cross total occlusions when over-the-wire balloons fail.[48] When a fixed wire-balloon system is used, a bare guidewire may be positioned beyond the stenosis to maintain distal access while the device is removed.

Table 16.11. Late Angiographic Results After Revascularization of Chronic Total Occlusion

Series	Occlusion	Device	N	Restenosis (%)	Reocclusion (%)
Noguchi[127] (2000)	Total	PTCA	134	40	-
Buller[128*] (1999)	Total	PTCA	208	70	-
Sievert[133*] (1999)	Total	PTCA	55	62	13
		Stent	55	26	2
Hoher[131*] (1999)	Total	PTCA	43	64	24
	Total	Stent	42	32	3
Lau[137] (1999)	Total	Stent	43	33	-
	Nontotal	Stent	43	28	-
Rubartelli[102*] (1998)	Total	PTCA	97 (overall)	68	24
		Stent		32	3
Nobuyoshi[119] (1998)	Total	PTCA	413	57	28
Mori[129]* (1996)	Total	PTCA	96 (overall)	56	11
		Stent		28	7
Sirens[88]* (1996)	Total	PTCA	114 (overall)	74	26
		Stent		57	12
Berger[30] (1996)	Total	PTCA	139	49	19
	Nontotal		1295	42	7
Kinoshita[9] (1995)	Total	PTCA	433	55	15
Violaris[31*] (1995)	Total	PTCA	266	45	19
	Nontotal		3317	34	5
	Absolute	PTCA	109	45	24
	Functional		157	45	16
Ishizaku[10] (1995)	Total	PTCA	62	55	18
Bell[16] (1992)	Total	PTCA	69	59	14
Ivanhoe[15] (1992)	Total	PTCA	175	54	16
Anderson[27] (1991)	Total	PTCA	70	71	34

* Randomized trial