

Stenting of coronary bifurcation lesions: case series.

Kotevski V, Pejkov H.

AIM: To assess the procedural success and major cardiac event rate after stenting of coronary bifurcation lesions. **METHODS:** The prospective study included 36 patients with coronary artery bifurcation lesion treated with stenting between January 1999 and December 2001 at the Institute for Heart Disease, Skopje University Center. There were 23 men and 13 women, with a mean age of 62.5+/-12.3 years. Seventeen patients had acute myocardial infarction and 19 patients had unstable angina. The follow-up lasted 6 months. The strategy of systematic coronary stenting in the bifurcation lesions involving a side branch of >2.2 mm in diameter was prospectively evaluated according to the quantitative coronary angiography (QCA) measurements. Procedural success was defined as a residual stenosis of less than 20%. Major cardiac events included deaths, emergency coronary artery bypass grafting (CABG), Q-wave myocardial infarction, acute and subacute closure, repeated percutaneous transluminal coronary angioplasty (PTCA), and non-Q myocardial infarction. **RESULTS:** Out of a total of 36 bifurcation lesions, the left anterior descending/diagonal bifurcation lesion was found in 22 patients, circumflex/marginal in 8 patients, posterior descending artery/posterolateral artery in 4 patients, and left main coronary artery in 2 patients. The main branch of the coronary artery (mean+/-SD reference diameter, or the diameter of the normal coronary artery, 2.90+/-0.36 mm) was stented in 35 patients and the side branch of the main coronary artery (2.35+/-0.42 mm reference diameter) in 24 patients. The major cardiac events occurred in 3 patients: one had Q-wave myocardial infarction, one developed acute and subacute closure, and one underwent PTCA. There were no deaths or emergency CABG. **CONCLUSION:** The development of new surgical strategies and stent design has improved the safety and immediate outcome of bifurcation stenting, but procedural success still needs to be matched by an equal clinical improvement and long-term patency.

Stenting of bifurcation lesions using the Bestent: a prospective dual-center study.

Gobeil F, Lefevre T, Guyon P, Louvard Y, Chevalier B, Dumas P, Glatt B, Loubeyre C, Royer T, Morice MC.

Treatment of bifurcation lesions remains a technical challenge. Among 13 stents previously tested in a bench study, the Bestent seemed of particular interest in this indication as it provided good access to the side branch after stent implantation in the main branch associated with a satisfactory coverage of the lesion after kissing balloon inflation. The use of Bestent implanted in the main branch or both branches for treatment of bifurcation lesions involving a side branch ≥ 2.2 mm in diameter was prospectively evaluated in a dual-center prospective study with a prospective 6-month clinical follow-up. All angiographic documents were analyzed by an independent corelab (CORISIS). Between 11 September 1997 and 21 February 1998, 96 patients were consecutively included (mean age, 63.7 \pm 11.4 years; 81.3% male; 58.3% with unstable angina and 6.3% acute myocardial infarction). The lesion involved the left anterior descending-diagonal coronary bifurcation in 55% of cases, left circumflex-marginal 23%, posterior descending-postero-lateral 12%, distal left main 6%, and others 4%. The main branch (proximal reference diameter: 3.43 \pm 0.45 mm) was stented in 98% of cases and the side branch (2.72 \pm 0.38 mm) in 38% (both branches in 34% of cases). T-stenting or provisional T-stenting was used in 88% of cases and final kissing balloon inflation was performed in 78% of cases. Procedural success was obtained in 100% of cases in the main branch and 98% in both branches. Major cardiac and cerebral events (MACCE) during hospitalization occurred in 4.2% of cases, non-Q-wave myocardial infarction (MI) in 3.1%, Q-wave MI in 1.0%, repeat PTCA in 2.1%; there were no major access site complication, no emergency coronary artery bypass grafting operation, no death. At 6-month follow-up, total MACCE rate was 14.6% (Q-wave MI, 3.1%; non-Q-wave MI, 3.1%; target vessel revascularization, 9.4%; death, 2.1%). Patients with target vessel revascularization (TVR) had restenosis of both branches in 22.2% of cases, main branch in 22.2%, and side branch in 55.6%. This study shows that using a simple strategy of provisional T-stenting of the side branch in the majority of cases, the Bestent can be used for treating bifurcation lesions with a high rate of success and an acceptable rate of TVR at 6-month follow-up.

Technical feasibility, safety, and clinical outcome of stenting of unprotected left main coronary artery bifurcation narrowing.

Park SJ, Lee CW, Kim YH, Lee JH, Hong MK, Kim JJ, Park SW.

This study was performed to evaluate the acute and long-term results of stenting for unprotected left main coronary artery (LMCA) bifurcation lesions. Sixty-three consecutive patients with an unprotected LMCA bifurcation lesion and normal left ventricular function were included. Stenting was performed with (n = 32) or without debulking atherectomy (n = 31) at the operator's discretion. Slotted-tube stents, coil stents, or bifurcation stents were used. The procedural success rate was 100%. In-hospital events including stent thrombosis, Q-wave myocardial infarction, and emergency bypass surgery did not occur in any patients. The angiographic follow-up rate was 86% (43 of the 50 eligible patients), and the restenosis rate was 28% (parent vessel only 14%, side branch only 9%, and both 5%). Restenosis at the parent vessel occurred less frequently in the debulking group than in the nondebulking group (5% vs 33%, respectively, p = 0.02). In multivariate analysis, the debulking procedure was an independent predictive factor of restenosis for the parent vessel (odds ratio 0.10, 95% confidence intervals 0.01 to 0.91, p = 0.04). Clinical follow-up was obtained in all patients at 19.9 +/- 13.7 months. There were 2 deaths (noncardiac origin), but no myocardial infarction during follow-up. Target lesion revascularization was required in 6 patients. The event-free survival rate (death, nonfatal myocardial infarction, and repeat revascularization) was 86% at the end of the follow-up period. In conclusion, stenting for an unprotected LMCA bifurcation lesion may be performed with a high procedural success rate and a favorable clinical outcome in selected patients with normal left ventricular function, suggesting that stenting would be an effective alternative to surgery in these patients.

Treatment of coronary bifurcation lesions by stent implantation only in parent vessel and angioplasty in sidebranch: immediate and long-term outcome.

Cervinka P, Stasek J, Pleskot M, Maly J.

The aim of this study was to evaluate the immediate and long-term outcome of intracoronary stent implantation for the treatment of bifurcation lesions. We treated 30 patients with bifurcation stenosis with the Bx Velocity stent implanted only in the parent vessel and with balloon angioplasty of the sidebranch. Angiographic success was 86.7% (n = 26 patients) in both branches and 100% in the main branch. Clinical success was achieved in 29 patients (96.7%). One patient (3.3%) suffered from a small non-Q wave myocardial infarction. All 30 patients underwent control coronary angiography at 6 months unless performed earlier due to symptoms. After the 6-month follow-up, a total of 27 patients (90%) were asymptomatic; angiographic restenosis (> 50%) was found in four cases (13.3%). There was no sidebranch restenosis. During the follow-up, one patient (3.3%) had unstable angina and angiography revealed severe diffuse restenosis within the whole stent; this patient was referred for coronary artery bypass surgery. Two patients had mild angina (Canadian Cardiovascular Society Class II) and 1 patient had silent ischemia during exercise stress test. These patients underwent repeat coronary angioplasty. The rate of major adverse cardiac events was 16.6% and target vessel revascularization rate was 13.3%. We concluded that stent implantation only in the parent vessel with angioplasty of the sidebranch in bifurcation lesions is safe and has a high clinical success rate and low rate of target lesion revascularization.

Sequential vs. kissing balloon angioplasty for stenting of bifurcation coronary lesions.

Brueck M, Scheinert D, Flachskampf FA, Daniel WG, Ludwig J.

Coronary angioplasty of bifurcation lesions remains a technical challenge and is believed to result in low procedural success associated with the risk of side-branch occlusion. Furthermore, long-term results are associated with a high rate of reintervention. The aim of the study was to evaluate the immediate and long-term clinical and angiographic results of sequential vs. simultaneous balloon angioplasty (kissing balloon technique) for stenting of bifurcation coronary lesions. Between December 1999 and January 2001, 59 patients underwent coronary angioplasty because of symptomatic bifurcation lesions type III (i.e., side branch originates from within the target lesion of the main vessel, and both main and side branch are angiographically narrowed more than 50%). Twenty-six patients were treated with simultaneous and 33 patients with sequential balloon angioplasty. Main-vessel stent placement was mandatory; side-branch stenting and platelet IIb/IIIa antagonists were allowed at the discretion of the operator. Kissing balloon technique offered no advantage in terms of procedural success or need for repeat target vessel revascularization due to restenosis at 6-month follow-up. Using sequential balloon angioplasty, permanent or transient side-branch compromise rate (TIMI flow < 3) was significantly higher than after kissing balloon technique (33% vs. 0%, respectively; $P = 0.003$). Major clinical events in-hospital or at 6-month follow-up, however, showed no significant differences. Kissing balloon angioplasty reduces the rate of transient side-branch occlusion compared to sequential PTCA but does not improve immediate or long-term outcome compared to sequential PTCA for stenting of bifurcation lesions.

A stepwise strategy for the stent treatment of bifurcated coronary lesions.

Pan M, Suarez de Lezo J, Medina A, Romero M, Segura J, Ramirez A, Pavlovic D, Hernandez E, Ojeda S, Adamuz C.

Several observational studies have shown a better late outcome in patients with coronary bifurcation lesions treated with stents in whom the side branch was not stented. Balloon dilation and provisional stenting for the side branch seem an attractive strategy to manage these challenging types of lesions. This study evaluated the results of a three-step phase strategy in the stent treatment of bifurcated coronary lesions. We treated 126 patients, 58 +/- 11 years old, with major coronary bifurcation stenosis. The therapeutic procedure was undertaken following three phases; progression through each phase was triggered by the failure of one procedure to achieve a <50% residual stenosis at the side branch: in the first step, balloon angioplasty of the side branch followed by stenting of the parent vessel; in the second, balloon redilation of the side-branch origin across the metallic structure of the stent; in the third, stenting of the side-branch origin. Immediate success was achieved in 116 patients (92%). Angiographic results in each phase were as follows: in the first step, 35 patients (28%) had procedural success, 3 patients had failure, and 88 crossed to the next step; in the second, 76 patients (86%) had procedural success, 7 patients had failure, and 5 crossed to the next step; in the third, all 5 patients had procedural success. The overall major cardiac event-free probability at 15 months was 78%. Target vessel revascularization took place in 19 patients (15%) and when stratified by phases were 13% of patients treated in the first step, 16% of patients in the second step, and 20% of patients in the third step. Patients with coronary stenosis at major bifurcations may be treated following an unitary stepwise approach. This attitude may avoid side-branch stent implantation in most patients, providing good immediate and long-term results.

Immediate and long-term clinical and angiographic results from Wiktor stent treatment for true bifurcation narrowings.

Anzuini A, Briguori C, Rosanio S, Tocchi M, Pagnotta P, Bonnier H, Gimelli G, Airolidi F, Margonato A, Legrand V, Colombo A.

From January 1996 to December 1998, 90 consecutive patients with true bifurcation lesions underwent percutaneous coronary angioplasty with Wiktor stent implantation in our centers. In 1 group (group I, n = 45), a simple approach (main vessel stenting and balloon angioplasty of the side branch) was pursued. In the other group (group II, n = 45), both the main vessel and the side branch were stented ("T" technique). There was no significant difference in clinical and angiographic characteristics between the 2 groups. Angiographic and procedural successes were 100% and 95.6%, respectively, in both groups. Angiographic results for the side branch were better in group II than in group I. In-hospital and long-term (12 month) major cardiac events were similar in the 2 groups. Target lesion revascularization was 15.5% in group I and 35.5% in group II (p = 0.12). In the main vessel, restenosis rate was 12.5% in group I and 25% in group II (p = 0.15). In the side branch, restenosis rate was 37.5% in group II and 12.5% in group I (p = <0.05; odds ratio 2.42; 95% confidence interval 1.05 to 6.26). Event-free probability at 12 months was 61% in group II and 80% in group I (p = 0.10). When dealing with true bifurcation lesions, a simple strategy is associated with a lower risk of restenosis in the side branch. In contrast, a complex approach does not appear to give any benefit in terms of early or long-term outcome or restenosis rate.

A new dedicated stent and delivery system for the treatment of bifurcation lesions: Preliminary experience.

Toutouzas K, Stankovic G, Takagi T, Albiero R, Corvaja N, Milici C, Di Mario C, Finci L, Colombo A.

We report the first clinical experience in eight patients with a new stent and delivery system specifically designed for the treatment of bifurcational lesions. The device (AST SLK-View system) consists of a premounted stent and a delivery system. The stent has a side aperture, which orients toward the ostium of the side branch. The system allows deployment of the stent while the access to both main and side branches is maintained by two wires. We evaluated this system in nine bifurcations. The location of bifurcations was left descending artery/diagonal branch in four lesions, left circumflex/obtuse marginal branch in three lesions, and postero-lateral branch/posterior descending artery in two lesions. Predilation was performed in six lesions of the main branches and in five lesions of the side branches. The stent was effectively delivered to all bifurcations except for one, in which the target lesion was located at a distal segment and the device could not be delivered. Following stent implantation in the main branch, two lesions at the side branches were treated by stent, while the other lesions were treated by balloon angioplasty without difficulty. Final kissing balloon was performed in four bifurcation lesions. No adverse event was observed during 1 month of clinical follow-up. Treatment of bifurcation lesions with this new dedicated device appears to be feasible. This new device may introduce a new approach for the treatment of coronary bifurcation lesions. *Cathet Cardiovasc Intervent* 2003;58:34-42. Copyright 2003 Wiley-Liss, Inc.

Triple wire technique for a bifurcation lesion and a subtotal occlusive lesion.

Jim MH, Chan RH, Lee SW.

In a critical distal right coronary artery bifurcation lesion, the proximal course of the posterior descending artery was also subtotally occluded. The posterior descending artery gave rise to a small sidebranch just before the occlusion. In the subsequent revascularization procedure, the bifurcation lesion was double-wired. One wire was placed in the postero-lateral branch, and another wire was intended for placement in the posterior descending artery, but it repeatedly selected the sidebranch despite multiple shapings of the wire tip. While the second wire was deliberately kept in the sidebranch, a third wire was used and crossed the occlusive lesion without much difficulty. The second wire was then withdrawn and the revascularization procedure proceeded in the usual manner. The positioning of the second wire in the sidebranch significantly shortened the procedure.

Rotational angiography of the carotid artery bifurcation: technical aspects and preliminary results.

Pozzi Mucelli F, Pecenco R, Calderan L, Pozzi Mucelli R.

PURPOSE: Rotational Angiography (RA), a new modality for performing conventional catheter angiography, enables an accurate evaluation of the artery to be obtained from different points of view by means of the contemporary rotation of the X-ray tube and image intensifier during intrarterial selective injection of contrast media. This paper describes the examination technique and compares the diagnostic accuracy of the RA oblique projections with the data obtained in the antero-posterior (AP) and latero-lateral (LL) projections in the study of the carotid bifurcation. **MATERIALS AND METHODS:** Thirty patients underwent RA of the supra-aortic vessels to evaluate the degree of a stenosis at the carotid bifurcation suspected at color Doppler imaging. The angiographic examinations were performed on a Philips Integris Allura system able to rotate the arc at a speed of 55 degrees /s with selective catheterisation of both common carotid arteries. **RESULTS:** The frame showing the greatest degree of stenosis was compared with the frames obtained in the AP and LL projections. 57/60 carotid bifurcations were assessable (3 cases of internal carotid arteries were obstructed). The degree of stenosis evaluated on the most significant of the oblique projections was superior to that shown in the AP and LL projections for 16/30 cases on the right side and for 14/27 cases on the left side. In 4/57 cases (7%) the degree of stenosis was modified from less than 70% to more than 70%. No adverse event was observed due to catheterisation. **CONCLUSIONS:** RA enables the complete three-dimensional evaluation of the carotid bifurcation, and generally yields more accurate information on the degree of the stenosis in comparison with AP and LL technique. The study was successfully carried out in all cases, however slightly longer examination times due to the setup requirements of the system. This was largely compensated by the quality of the information yielded, which required no additional projections to be performed. Moreover, the high frame rate of 25 frames per second showed the haemodynamic flow through the lesion.

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Contemporary coronary intervention in bifurcation lesions - two-year follow-up in an unselected cohort.

Dudek D, Legutko J, Zymek P, Kaluza GL, Dubiel JS.

BACKGROUND: Optimization of coronary angioplasty in bifurcation lesions remains a major challenge for percutaneous revascularization techniques. MATERIAL/METHODS: We evaluated procedural success, major in-hospital complications, target vessel revascularization, and 2-year clinical outcomes in 45 patients who underwent PTCA of a bifurcation lesion using currently available techniques and rigorous criteria for optimal immediate RESULTS: Angiographic success occurred in 100% of the parent vessels and in 84.4% of both vessels. Within the first 24 hours, there were no deaths or Q-wave myocardial infarction. Three non-Q-wave myocardial infarctions occurred (6.6%) and one emergency PTCA was necessary (2.2%). Therefore, clinical success was achieved in 91.2% of these patients. At 2-year follow-up, 3 cardiac deaths had occurred, the target revascularization rate was 20%, and the total frequency of major adverse cardiac events (MACE) was 37.8%. CONCLUSIONS: Optimization of coronary angioplasty in bifurcation lesions is possible and results in a high angiographic success rate, low risk of acute complications and acceptable long-term clinical outcomes. However, the fairly high incidence of MACE at 2 years suggests that bifurcation lesions remain a challenge in everyday practice despite contemporary intervention methods and the use of GPIIb/IIIa inhibitors.

Sequential vs. kissing balloon angioplasty for stenting of bifurcation coronary lesions.

Brueck M, Scheinert D, Flachskampf FA, Daniel WG, Ludwig J.

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Immediate and long-term clinical and angiographic results from Wiktor stent treatment for true bifurcation narrowings.

Anzuini A, Briguori C, Rosanio S, Tocchi M, Pagnotta P, Bonnier H, Gimelli G, Airolidi F, Margonato A, Legrand V, Colombo A.

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Bifurcation lesion

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9. Triple wire technique for a bifurcation lesion and a subtotal occlusive lesion.

Jim MH, Chan RH, Lee SW.

J Invasive Cardiol 2003 Jan;15(1):43-5

10. Rotational angiography of the carotid artery bifurcation: technical aspects and preliminary results.

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Radiol Med (Torino) 2002 Sep;104(3):157-64

11. Treatment of coronary bifurcation lesions by stent implantation only in parent vessel and angioplasty in sidebranch: immediate and long-term outcome.

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12. Contemporary coronary intervention in bifurcation lesions - two-year follow-up in an unselected cohort.

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Am J Cardiol 2001 Dec 1;88(11):1246-50

Am J Cardiol 2001 May 15;87(10):1139-44

Immediate and one-year outcome in patients with coronary bifurcation lesions in the modern era (NHLBI dynamic registry).

Al Suwaidi J, Yeh W, Cohen HA, Detre KM, Williams DO, Holmes DR Jr.

Balloon angioplasty of bifurcation lesions has been associated with lower success and higher complication rates than most other lesion types. The development of alternative strategies such as debulking and stenting, either

alone or in combination, are currently used relatively often. The relative role of these newer approaches in improving acute or long-term outcome, however, remains uncertain. Of the total of 2,436 patients treated between July 1997 to February 1998 in the National Heart, Lung, and Blood Institute Dynamic Registry, there were 321 patients (group 1) with bifurcation lesions and 2,115 patients without any bifurcation lesions attempted (group2). Treatment strategies in terms of major devices used were significantly different between the 2 groups (group 1 vs 2): balloon angioplasty alone (23.1% vs 26.5%), balloon angioplasty and rotational atherectomy (6.9% vs 4.4%), balloon angioplasty and stent (55.8% vs 59.9%), and balloon angioplasty, rotational atherectomy, and stent (10.3% vs 7%) with $p < 0.01$. There were no significant differences between the groups in terms of age, gender, and frequency of prior myocardial infarction (MI) or coronary artery bypass graft surgery (CABG). Complete angiographic success was achieved in only 86% of bifurcation lesions versus 93.5% of nonbifurcation lesions ($p < 0.001$). In-hospital complication rates were increased in patients with bifurcation lesions compared with the nonbifurcation group: MI, 3.7% versus 2.6%; CABG, 2.2% versus 1.1%; side branch occlusion, 7.3% versus 2.3% ($p < 0.001$); and the composite of death, MI, and any CABG, 7.2% versus 5.0%. At 1-year follow-up, major adverse cardiac events were 25% higher in group 1 than in group 2 (32.1% vs 25.7%, $p < 0.05$). We conclude that despite the widespread use of newer percutaneous devices, treatment of bifurcation lesions remains difficult and is associated with decreased success and increased complication rates compared with nonbifurcation lesions.

Catheter Cardiovasc Interv 2001 May;53(1):12-20

Directional atherectomy prior to stenting in bifurcation lesions: a matched comparison study with stenting alone.

Karvouni E, Di Mario C, Nishida T, Tzifos V, Reimers B, Albiero R, Corvaja N, Colombo A.

The ideal catheter-based intervention for treatment of coronary lesions at bifurcation site still has to be defined. The aim of the study was to assess the acute and long-term outcome after treatment of bifurcation lesions with directional atherectomy (DCA) and stenting in comparison with stenting alone. Thirty-one consecutive patients treated for bifurcation coronary lesions (62 lesions) with DCA and stenting in at least one branch (DCA group) were compared with a matched group of 31 patients with bifurcation coronary lesions (62 lesions) treated with stenting alone in at least one branch (non-DCA group). Procedural success was 87.1% in the DCA group compared with 100% in the non-DCA group ($P = 0.03$). In-hospital major adverse cardiac events (MACE)

occurred only in the DCA group (12.9% vs. 0%, $P = 0.03$), mainly non-Q-wave myocardial infarction. After the procedure, minimum lumen diameter (MLD) and acute gain were significantly greater ($P = 0.004$ and $P = 0.05$, respectively) and % diameter stenosis was significantly lower ($P = 0.05$) in the main branch in the DCA group. At follow-up angiogram, MLD in the main branch was still significantly greater in the DCA group compared to the non-DCA group (2.31 vs. 1.65, respectively, $P = 0.04$), with no significant difference in late loss and loss index between the two groups. Restenosis rate was 28.8% in the DCA group vs. 43.5% in the non-DCA group ($P = 0.13$). The incidence of follow-up MACE was 29% in the DCA group compared with 48.4% in the non-DCA group, mainly due to target lesion revascularization. In conclusion, treatment of bifurcation coronary lesions with DCA and stenting was associated with greater acute gain after the procedure and greater MLD at follow-up in the main branch compared with stenting alone. Procedural myocardial infarction was more frequent in the DCA group. Restenosis rates and follow-up MACE were lower following DCA and stenting, without reaching any statistical significance.

Cardiology 2001;95(4):198-205

High-speed rotational atherectomy in the treatment of bifurcation-type coronary lesions.

Nageh T, Kulkarni NM, Thomas MR.

BACKGROUND: Bifurcational coronary lesions present a major interventional challenge. The differential cutting mechanism of high-speed rotational atherectomy (HSRA) may provide a favourable technique of treating this complex lesion subtype. **METHODS:** We evaluated the use of HSRA (32 lesions) compared to balloon angioplasty (BA) (118 lesions), with provisional stenting in both groups, in a non-randomised, retrospective study of 150 bifurcation-type lesions. **RESULTS:** The HSRA/stent group had a high primary success rate of 97%, an acceptably low in-hospital event rate of 9% and an overall major adverse cardiac event (MACE) rate at a mean follow-up period of 15 +/- 3.4 months of 22.5% with a target lesion revascularisation (TLR) rate of 18.7%. Procedural success in the BA/stent group was 81% with an in-hospital event rate of 14.4%, and the overall MACE rate at follow-up was 27.5% with a TLR rate of 23%. We achieved a greater acute gain in minimal luminal diameter and a lesser percentage of residual stenosis after intervention in the HSRA/stent group compared to the BA/stent group ($p < 0.01$). Outcome at follow-up favoured the HSRA/stent group, although the difference did not reach statistical significance. **CONCLUSION:** HSRA with provisional stenting provided a safe and effective means of treating bifurcation lesions. Copyright 2001 S. Karger AG, Basel

Am J Cardiol 2001 Dec 1;88(11):1246-50

Immediate and long-term clinical and angiographic results from Wiktor stent treatment for true bifurcation narrowings.

Anzuini A, Briguori C, Rosanio S, Tocchi M, Pagnotta P, Bonnier H, Gimelli G, Airolidi F, Margonato A, Legrand V, Colombo A.

From January 1996 to December 1998, 90 consecutive patients with true bifurcation lesions underwent percutaneous coronary angioplasty with Wiktor stent implantation in our centers. In 1 group (group I, n = 45), a simple approach (main vessel stenting and balloon angioplasty of the side branch) was pursued. In the other group (group II, n = 45), both the main vessel and the side branch were stented (??technique). There was no significant difference in clinical and angiographic characteristics between the 2 groups. Angiographic and procedural successes were 100% and 95.6%, respectively, in both groups. Angiographic results for the side branch were better in group II than in group I. In-hospital and long-term (12 month) major cardiac events were similar in the 2 groups. Target lesion revascularization was 15.5% in group I and 35.5% in group II (p = 0.12). In the main vessel, restenosis rate was 12.5% in group I and 25% in group II (p = 0.15). In the side branch, restenosis rate was 37.5% in group II and 12.5% in group I (p = <0.05; odds ratio 2.42; 95% confidence interval 1.05 to 6.26). Event-free probability at 12 months was 61% in group II and 80% in group I (p = 0.10). When dealing with true bifurcation lesions, a simple strategy is associated with a lower risk of restenosis in the side branch. In contrast, a complex approach does not appear to give any benefit in terms of early or long-term outcome or restenosis rate.

Catheter Cardiovasc Interv 2002 Jan;55(1):50-7

A stepwise strategy for the stent treatment of bifurcated coronary lesions.

Pan M, Suarez de Lezo J, Medina A, Romero M, Segura J, Ramirez A, Pavlovic D, Hernandez E, Ojeda S, Adamuz C

Several observational studies have shown a better late outcome in patients with coronary bifurcation lesions treated with stents in whom the side branch was not stented. Balloon dilation and provisional stenting for the side branch seem an attractive strategy to manage these challenging types of lesions. This study evaluated the results of a three-step phase strategy in the stent treatment of bifurcated coronary lesions. We treated 126 patients, 58 +/- 11 years old, with major coronary bifurcation stenosis. The therapeutic procedure was undertaken following three phases; progression through each phase was triggered by the failure of one procedure to achieve a <50% residual stenosis at the side branch: in the first step, balloon angioplasty of the side branch followed by stenting of the parent vessel; in the second, balloon redilation of the side-branch origin across the metallic structure of the stent; in the third, stenting of the side-branch origin. Immediate success was achieved in 116 patients (92%). Angiographic results in each phase were as follows: in the first step, 35 patients (28%) had procedural success, 3 patients had failure, and 88 crossed to the next step; in the second, 76 patients (86%) had procedural success, 7 patients had failure, and 5 crossed to the next step; in the third, all 5 patients had procedural success. The overall major cardiac event-free probability at 15 months was 78%. Target vessel revascularization took place in 19 patients (15%) and when stratified by phases were 13% of patients treated in the first step, 16% of patients in the second step, and 20% of patients in the third step. Patients with coronary stenosis at major bifurcations may be treated following an unitary stepwise approach. This attitude may avoid side-branch stent implantation in most patients, providing good immediate and long-term results. Copyright 2002 Wiley-Liss, Inc.

Am J Cardiol 1996;78:1039-1041

A Comparison of Debulking Versus Dilation of Bifurcation Coronary Arterial Narrowings (from the CAVEAT I Trial)

Sorin J. Brener, MD, Ferdinand S. Leya, MD, Carolyn Apperson-Hansen, MS, Michael J. Cowley, MD, Robert M. Califf, MD, and Eric J. Topol, MD

There are few published data regarding the effectiveness of directional coronary atherectomy (DCA) in bifurcation lesions, but, empirically, DCA has been widely applied for this complex morphology, because of its potential to remove plaque, preserve the side branch ostium, and prevent plaque shifting and dissections. We

examined the relative merit of DCA compared with coronary angioplasty (PTCA) in the treatment of bifurcation coronary lesions in patients enrolled in the multicenter, randomized Coronary Angioplasty Versus Excisional Atherectomy Trial-I (CAVEAT I) with respect to in-hospital complications and 6-month angiographic restenosis. We also examined the impact of a bifurcation lesion on periprocedural complications and angiographic restenosis, regardless of the device utilized.

Summary

* $p < 0.001$

Am J Cardiol 1996;77:1226-1229

Stent Jail: A Minimum-Security Prison

Ronald P. Caputo, MD, Edward R. Chafizadeh, MD, Robert C. Stoler, MD, John J. Lopez, MD, David J. Cohen, MD, Richard E. Kuntz, MD, Joseph P. Carrozza, Jr, MD, and Donald S. Baim, MD

Coronary stents have emerged as effective therapy for the treatment of selected obstructive atherosclerotic coronary lesions and now compose up to 50% of coronary interventional procedures in our catheterization laboratory. Complications of coronary stent placement are uncommon but include inability to place the device, stent embolization, dissection distal to the stent, and acute or subacute thrombosis. Another potential complication is narrowing or occlusion of the ostium of a side branch spanned by the stent, due to longitudinal redistribution of atherosclerotic plaque ("snowplowing") during expansion of the lesion in the parent vessel. This complication occurs in 6% to 13% of side branches after stent implantation. When similar snowplowing of side branches occurs after balloon angioplasty, it can often be treated successfully by balloon angioplasty of the affected branch. In contrast, stent placement across a side branch results in partial blockade of the side-branch ostium by stent struts (stent jail), which restricts access to the side branch and theoretically makes branch angioplasty technically difficult. This study, however, describes a series of patients in whom angioplasty through stent diamond or articulation site was attempted for treatment of compromised side branches.

Summary

1. Procedure success rate: 84%

2. No balloon entrapment or deterioration of the final parent vessel result

Table. Side-branch changes

* $p < 0.01$

Journal of the American College of Cardiology, 1998;32:7:1845-1852

Mechanical debulking versus balloon angioplasty for the treatment of true bifurcation lesions

Harold L. Dauerman, Peter J. Higgins, Anthony M. Sparano, C. Michael Gibson, Gary R. Garber, Joseph P. Carrozza, Jr., Richard E. Kuntz, Roger J. Laham, Samuel J. Shubrooks, Jr., Donald S. Baim, David J. Cohen

Objectives. The purpose of this study was to compare the immediate angiographic and long-term results of debulking versus balloon angioplasty for treatment of true bifurcation lesions.

Background. Previous studies have shown true bifurcation lesions to be a high risk morphological subset for percutaneous transluminal coronary angioplasty (PTCA). Although atherectomy devices have been used to treat bifurcation lesions, no studies have compared the outcomes of these alternative treatment modalities.

Methods. Between January 1992 and May 1997, we treated 70 consecutive patients with true bifurcation lesions (defined as a greater than 50% stenosis in both the parent vessel and contiguous side branch) with conventional PTCA (n = 30) or debulking (with rotational or directional atherectomy) plus adjunctive PTCA (n = 40). Paired angiograms were analyzed by quantitative angiography, and clinical follow-up was obtained in all patients.

Results. Acute procedural success was 73% in the PTCA group and 97% in the debulking group ($p = 0.01$). Major in-hospital complications occurred in two patients in the PTCA group and one in the debulking group. Treatment with atherectomy plus PTCA resulted in lower postprocedure residual stenoses than PTCA alone ($16 \pm 15\%$ vs. $33 \pm 17\%$ in the parent vessel, and $6 \pm 15\%$ vs. $39 \pm 22\%$ in the side branch; $p < 0.001$ for both comparisons). At 1 year follow-up, the incidence of target vessel revascularization (TVR) was 53% in the PTCA group as compared with 28% in the debulking group ($p = 0.05$). Independent predictors of the need for repeat TVR were side branch diameter >2.3 mm, longer lesion lengths, and treatment with PTCA alone.

Conclusions. For the treatment of true bifurcation lesions, atherectomy with adjunctive PTCA is safe, improves acute angiographic results, and decreases target vessel revascularization compared to PTCA alone. The benefits of debulking for bifurcation lesions were especially seen in lesions involving large side branches.

Am J Cardiol 1999 May 1;83(9):1320-5

Simple and complex stent strategies for bifurcated coronary arterial stenosis involving the side branch origin.

Pan M, Suarez de Lezo J, Medina A, Romero M, Hernandez E, Segura J, Castroviejo JR, Pavlovic D, Melian F, Ramirez A, Castillo JC

Coronary lesions located in major bifurcations constitute a challenge for the use of stents. Although the occlusion of a side branch covered by a stent is infrequent, the maintenance of a patent, stenosis-free bifurcation may result in a complex procedure. Between September 1994 and April 1998, 70 patients were treated by stent implantation for coronary bifurcation stenosis. The side branch always had a diameter >2 mm. The pairs of treated arteries were: left anterior descending (LAD)/diagonal artery in 32 patients, circumflex/obtuse marginal in 26, right coronary/posterior descending artery in 5, and LAD/circumflex in 7. We applied 2 different techniques of stent implantation: (1) deployment of 1 stent in the parent vessel covering the takeoff of the side branch and subsequent angioplasty of the side branch across the metallic structure (group A, n = 47 patients), and (2) implantation of 1 stent at the ostium of the side branch and complete reconstruction of the entire bifurcation with additional implantation of 1 or 2 stents at the parent vessel (group B, n = 23 patients). There were no significant differences between groups at baseline variables. Procedural success was similar in both groups: 42 (89%) in group A versus 21 (91%) in group B. However, major cardiac events at 18 months follow-up were higher in group B (event-free probability 44% vs 75%, $p < 0.05$). Selected patients with coronary stenosis at major bifurcations can be treated with an acceptable rate of primary and late success. Complex techniques providing radical stent reconstruction of the bifurcation seems to provide no advantages over the simpler stent jail followed by ostial side branch balloon dilation.

Summary

* $p < 0.05$

Journal of the American College of Cardiology, 2000;35:4:929-936

Immediate and long-term outcome of intracoronary stent implantation for true bifurcation lesions

Jassim Al Suwaidi, Peter B. Berger, Charanjit S. Rihal, Kirk N. Garratt, Malcolm R. Bell, Henry H. Ting, John F. Bresnahan, Diane E. Grill, David R. Holmes, Jr.

OBJECTIVES The aim of this study was to evaluate the immediate and long-term outcome of intracoronary stent implantation for the treatment of coronary artery bifurcation lesions. **BACKGROUND**

Balloon angioplasty of true coronary bifurcation lesions is associated with a lower success and higher complication rate than most other lesion types.

METHODS We treated 131 patients with bifurcation lesions with 1 stent. Patients were divided into two groups; Group (Gp) 1 included 77 patients treated with a stent in one branch and percutaneous transluminal coronary angioplasty (PTCA) (with or without atherectomy) in the side branch, and Gp 2 included 54 patients who underwent stent deployment in both branches. The Gp 2 patients were subsequently divided into two subgroups depending on the technique of stent deployment. The Gp 2a included 19 patients who underwent Y-stenting, and Gp 2b included 33 patients who underwent T-stenting.

RESULTS There were no significant differences between the groups in terms of age, gender, frequency of prior myocardial infarction (MI) or coronary artery bypass grafting (CABG), or vessels treated. Procedural success rates were excellent (89.5 to 97.4%). After one-year follow-up, no significant differences were seen in the frequency of major adverse events (death, MI, or repeat revascularization) between Gp 1 and Gp 2. Adverse cardiac events were higher with Y-stenting compared with T-stenting (86.3% vs. 30.4%, $p = 0.004$).

CONCLUSIONS Stenting of bifurcation lesions can be achieved with a high success rate. However, stenting of both branches offers no advantage over stenting one branch and performing balloon angioplasty of the other branch.

Journal of the American College of Cardiology, 2000;35:5:1145-1151

Bifurcation lesions: two stents versus one stent-immediate and follow-up results

Takehiro Yamashita, Takahiro Nishida, Milena G. Adamian, Carlo Briguori, Marco Vaghetti, Nicola Corvaja, Remo Albiero, Leo Finci, Carlo Di Mario, Jonathan M. Tobis, Antonio colomobo

OBJECTIVES The purpose of this study was to evaluate two different techniques of stent placement in bifurcation lesions.

BACKGROUND Although stent placement with dedicated techniques has been suggested to be a useful therapeutic modality for bifurcation lesions, limited information is available if stent placement on the side branch and on the parent branch provides any advantage over a simpler strategy of stenting the parent vessel and balloon angioplasty of the side branch.

METHODS Between March 1993 and April 1999, we treated a total of 92 patients with bifurcation lesions with

two strategies: stenting both vessels (group B, n = 53) or stenting the parent vessel and balloon angioplasty of the side branch (group P, n = 39). Paired angiograms were analyzed by quantitative angiography, and clinical follow-up was obtained.

RESULTS Stent placement on both branches resulted in a lower residual stenosis ($7.4 \pm 10.9\%$ vs. $23.4\% \pm 18.7\%$, $p < 0.001$) in the side branch. Acute procedural success was similar in the two groups (group B: 87% vs. Group P: 92%). In-hospital major adverse cardiac events (MACE) occurred only in group B (13% vs. 0%, $p < 0.05$). At the six-month follow-up, the angiographic restenosis rate (group B: 62% vs. Group P: 48%) and the target lesion revascularization rate (38% vs. 36%, respectively) were similar in the two groups. There was no difference in the incidence of six-month total MACE (51% vs. 38%).

CONCLUSIONS For the treatment of true bifurcation lesions, a complex strategy of stenting both vessels provided no advantage in terms of procedural success and late outcome versus a simpler strategy of stenting only the parent vessel.

The American Journal of Cardiology, 85:9:1141-1144

Immediate and long-term results of “ T” stenting for bifurcation coronary lesions

Imad Sheiban, Remo Albiero, Federica Marsico, Aniruddha Dharmadhikari, Vaios Tzifos, Paolo Pagnotta, Matteo Montorfano, Filippo Leonardo, Piersergio Saba, Carlo Di Mario, Antonio Colombo

The use of high-pressure stent expansion and the combination of effective antiplatelet drugs have contributed to the extensive use of percutaneous transluminal coronary angioplasty (PTCA), even in high-risk clinical and angiographic subsets, making this procedure a routine method of treatment for most coronary lesions. However, interventions on bifurcation coronary lesions remain complex, especially when the stenosis involves the origins of both branches. Plaque shift leading to side-branch occlusion can complicate the procedure and negatively influence the clinical outcome. Various techniques have been used and analyzed to optimize the angiographic result and the clinical outcome of patients with bifurcation coronary lesions. However, these studies have had a relatively small number of patients and there is scarce data on long-term results. The present study evaluates immediate and long-term results of coronary bifurcation lesions treated with stent implantation in both the main vessel and the side branch using the ??technique.

Cathet. Cardiovasc. Intervent. 49:274-283, 2000.

Stenting of bifurcation lesions: Classification, treatments, and results

Thierry Lefevre, Yves Louvard, Marie-Claude Morice, Pierre Dumas, Christophe Loubeyre, Abdeljabbar Benslimane, Rajendra Kumar Premchand, Niels Guillard, Jean-Francois Piechaud

Percutaneous transluminal balloon coronary angioplasty (PTCA) of coronary bifurcations is associated with a low success rate, high rate of complications, and high incidence of target vessel revascularization (TVR). The strategy of systematic coronary stenting in bifurcation lesions involving a side branch ≥ 2.2 mm in diameter was prospectively evaluated in a single-center observational study during a 35-month inclusion period. All patients meeting these criteria were consecutively included. Bifurcation lesions and treatment were predefined in the study. The study included 366 patients (12.1% of PTCA) with 373 bifurcation lesions, mean age 63.7 ± 11.6 years, 79.2% male, 46.7% with unstable angina, and 8.3% acute MI. The left anterior descending/diagonal bifurcation was involved in 55.2% of cases, circumflex/marginal 22.2%, PDA/PLA 10.4%, left main bifurcation in 6.8%, and others 5.4%. The main branch (2.78 ± 0.42 mm reference diameter) was stented in 96.3% of cases and the side branch (2.44 ± 0.43 mm) in 63.2% (the two branches were stented in 59.5% of cases). Procedural success was obtained in 96.3% in both branches and 99.4% in the main branch. At 1-month follow-up, The major cardiac event rate (MACE) was 4.8% (death 1.1%, emergency CABG 0.6%, Q-wave MI 0.9%, acute or subacute closure 1.4%, repeat PTCA 1.1%, and non-Q-wave MI 2.3%). At 7-month follow-up, the total MACCE rate was 21.6%, including a TVR rate of 17.2%. Analysis of the 7-month outcome according to two study periods (period I, 1 January 1996 to 31 August 1997, 182 patients; period II, 1 September 1997 to 30 June 1998, 127 patients) showed that the TVR rate decreased from 20.6% to 13.8% ($P = 0.04$) and the MACE rate from 29.2% to 17.1% ($P < 0.01$) in period I and II, respectively. This was associated by univariate analysis with an increasing use of tubular stents deployed in the main branch (94.2% vs. 59.1%, $P < 0.001$) and kissing balloon inflation after coronary stenting (75.4% vs. 18.1%, $P < 0.001$). Bifurcation lesions are frequent. Procedural success of coronary stenting is high with a low rate of in-hospital MACE. TVR rate at follow-up is relatively low. In-hospital and follow-up results are influenced not only by the learning curve but also by the use of tubular stents in the main branch and final kissing balloon inflation.

Bifurcation lesion

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Al Suwaidi J, Yeh W, Cohen HA, Detre KM, Williams DO, Holmes DR Jr.

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Karvouni E, Di Mario C, Nishida T, Tzifos V, Reimers B, Albiero R, Corvaja N, Colombo A.

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3. High-speed rotational atherectomy in the treatment of bifurcation-type coronary lesions.

Nageh T, Kulkarni NM, Thomas MR.

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4. Immediate and long-term clinical and angiographic results from Wiktor stent treatment for true bifurcation narrowings.

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5. A stepwise strategy for the stent treatment of bifurcated coronary lesions.

Pan M, Suarez de Lezo J, Medina A, Romero M, Segura J, Ramirez A, Pavlovic D, Hernandez E, Ojeda S, Adamuz C

Catheter Cardiovasc Interv 2002 Jan;55(1):50-7

6. A Comparison of Debulking Versus Dilation of Bifurcation Coronary Arterial Narrowings (from the CAVEAT I Trial)

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Am J Cardiol 1996;78:1039-1041

7. Stent Jail: A Minimum-Security Prison

Ronald P. Caputo, MD, Edward R. Chafizadeh, MD, Robert C. Stoler, MD, John J. Lopez, MD, David J. Cohen, MD, Richard E. Kuntz, MD, Joseph P. Carrozza, Jr, MD, and Donald S. Baim, MD

Am J Cardiol 1996;77:1226-1229

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D. Bocker, M. Block, M. Borggreffe, G. Breithardt

Volume 18, Issue 1, January 1997 p26-30

9. Mechanical debulking versus balloon angioplasty for the treatment of true bifurcation lesions

Harold L. Dauerman, Peter J. Higgins, Anthony M. Sparano, C. Michael Gibson, Gary R. Garber, Joseph P. Carrozza, Jr., Richard E. Kuntz, Roger J. Laham, Samuel J. Shubrooks, Jr., Donald S. Baim, David J. Cohen

Journal of the American College of Cardiology, 1998;32:7:1845-1852

10. Simple and complex stent strategies for bifurcated coronary arterial stenosis involving the side branch origin.

Pan M, Suarez de Lezo J, Medina A, Romero M, Hernandez E, Segura J, Castroviejo JR, Pavlovic D, Melian F, Ramirez A, Castillo JC

Am J Cardiol 1999 May 1;83(9):1320-5

11. Immediate and long-term outcome of intracoronary stent implantation for true bifurcation lesions

Jassim Al Suwaidi, Peter B. Berger, Charanjit S. Rihal, Kirk N. Garratt, Malcolm R. Bell, Henry H. Ting, John F. Bresnahan, Diane E. Grill, David R. Holmes, Jr.

Journal of the American College of Cardiology, 2000;35:4:929-936

12. Bifurcation lesions: two stents versus one stent-immediate and follow-up results

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Journal of the American College of Cardiology, 2000;35:5:1145-1151

13. Immediate and long-term results of "T" stenting for bifurcation coronary lesions

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The American Journal of Cardiology, 85:9:1141-1144

14. Stenting of bifurcation lesions: Classification, treatments, and results

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Cathet. Cardiovasc. Intervent. 49:274-283, 2000.