Comparison of safety and efficacy of paclitaxel-eluting stents with durable versus biodegradable polymer implanted in saphenous vein graft lesions. Nine-month angiographic and intravascular ultrasound follow-up

Porównanie bezpieczeństwa i skuteczności stentów uwalniających paklitaksel z polimeru trwałego i biodegradowalnego w zmianach zlokalizowanych w żylnych pomostach aortalno-wieńcowych. Ocena angiograficzna i metodą ultrasonografii wewnątrznaczyniowej po dziewięciu miesiącach od implantacji stentu

Jerzy Pregowski[1], Adam Witkowski[1], Zbigniew Chmielak[1], Łukasz Kalińczuk[1], Andrzej Ciszewski[1], Maciej Karcz[1], Jakub Przyłuski[1], Jan Jastrzebski[1], Rafał Wolny[1], Mieczysław Dziarmaga[2]

[1]Institute of Cardiology, Warsaw, Poland
[2]Poznan University of Medical Science, Poland

Postep Kardiol Inter 2012; 8, 4 (30): 269–274
DOI: 10.5114/pwki.2012.31906

Abstract

Aim: To compare safety and efficacy of stents eluting paclitaxel from biodegradable (Luc Chopin^2 stent) versus durable (Taxus Liberté stent) polymer implanted into saphenous vein grafts (SVGs).

Material and methods: Consecutive patients with stable angina or non-ST elevation acute coronary syndrome with culprit de-novo lesions in SVGs were enrolled. The patients were randomized to treatment with Luc Chopin^2 or Taxus Liberté stents. The primary endpoint was neointimal hyperplasia volume measured with intravascular ultrasound performed 9 months after stent implantation. The secondary endpoint was late lumen loss assessed angiographically at 9-month follow-up. We randomized 26 patients to the Taxus Liberté group and 25 patients to the Luc Chopin^2 group.

Results: During 9-month follow-up the frequency of cardiac death (0% vs. 8%, $p = 0.5$) and target lesion revascularization (20% vs. 4%; $p = 0.2$) was not significantly different in the Luc Chopin^2 and Taxus Liberté groups. We did not observe a significant difference in the neointima hyperplasia volume between Luc Chopin^2 and Taxus stents (15.8 ±14.5 mm^3 vs. 11.9 ±29.4 mm^3; $p = 0.1$). However, late lumen loss was larger in lesions treated with Luc Chopin^2 stents (0.59 ±0.74 mm vs. 0.30 ±0.81 mm; $p = 0.015$).

Conclusions: Luc Chopin^2 stents eluting paclitaxel from biodegradable polylactic-co-glycolic polymer implanted into SVGs seem to be less effective in inhibition of neointimal proliferation assessed angiographically than durable polymer Taxus Liberté stents.

Key words: drug-eluting stent saphenous, vein graft

Streszczenie

Cel: Porównanie skuteczności i bezpieczeństwa implantacji stentów uwalniających paklitaksel z polimeru biodegradowalnego (Luc Chopin2 stent) i trwałego (Taxus Liberté stent) w żylnych pomostach aortalno-wieńcowych (*saphenous vein grafts* – SVGs).

Materiał i metody: Do badania włączone zostały kolejne osoby ze stabilną chorobą wieńcową lub ostrym zespołem wieńcowym bez uniesienia odcinka ST, z istotnym zwężeniem odpowiedzialnym za objawy, zlokalizowanym w pomoście aortalno-wieńcowym. Pacjentów randomizowano do leczenia implantacją stentu Luc Chopin^2 lub Taxus Liberté. Pierwszorzędowym punktem końcowym badania była objętość neointimy oceniana metodą ultrasonografii wewnątrznaczyniowej po 9 miesiącach od implantacji stentu. Drugorzędowy punkt końcowy stanowiła późna utrata światła naczynia w stencie (*late loss*) w ocenie angiograficznej. Stent Taxus Liberté implantowano u 26 pacjentów, natomiast stent Luc Chopin^2 u 25 chorych.

Wyniki: W trakcie 9-miesięcznej obserwacji nie stwierdzono istotnych różnic w częstości występowania zgonów sercowych (0% *vs* 8%, $p = 0,5$) i ponownej rewaskularyzacji (20% *vs* 4%; $p = 0,2$). Nie obserwowano istotnej różnicy w objętości neointimy pomię-

Corresponding autor/*Adres do korespondencji:*
Jerzy Pregowski MD, PhD, Institute of Cardiology, 42 Alpejska St, 04-628 Warsaw, Poland, tel.: + 48 501 472 421,
e-mail: jerzypregowski74@gmail.com
Praca wpłynęła: 14.09.2012, **przyjęta do druku:** 30.10.2012.

dzy grupą, w której stosowano stent Luc Chopin2, a grupą z implantowanym stentem Taxus (15,8 ±14,5 mm3 *vs* 11,9 ±29,4 mm3; *p* = 0,1).W przypadku zmian miażdżycowych leczonych implantacją stentu Luc Chopin2 późna utrata światła naczynia była większa niż w przypadku implantacji stentów Taxus (0,59 ±0,74 mm *vs* 0,30 ±0,81 mm; *p* = 0,015).

Wnioski: Implantacja stentów Luc Chopin2 uwalniających paklitaksel z biodegradowalnego kopolimeru kwasu mlekowego i glikolowego wydaje się mniej skuteczna w hamowaniu proliferacji neointimy ocenianej angiograficznie w porównaniu ze stentami Taxus Liberté.

Słowa kluczowe: stenty uwalniające leki, pomosty żylne

Background

Drug-eluting stents (DES) are superior to bare metal stents (BMS) in the majority of lesions in native coronary arteries due to more than 50% reduction in the restenosis rate [1-5]. Percutaneous coronary intervention (PCI) with stent implantation is the most often utilized revascularization strategy also for saphenous vein graft stenosis. However, although up to 10% of PCI procedures are performed in SVGs this lesion subset is underrepresented in the DES trials [6-8]. The 3-year follow-up of the RRISC study in which patients with SVG stenosis were randomized to DES versus BMS showed significantly higher mortality in the DES group [9]. The authors suggested that this unfavorable outcome could be attributed to the enhanced inflammatory and thrombotic reaction within the unstable SVG atheroma induced by drug and/or polymer coating the stent. Reduction of prolonged tissue exposure to the polymer by using stents coated with biodegradable polymer could theoretically limit the inflammation and hence reduce the incidence of unfavorable clinical events. On the other hand, it has been shown that CoStar stents (Conor MedSystems, Menlo Park, California) eluting paclitaxel from biodegradable polymer were inferior to Taxus stents coated with durable polymer due to the higher rate of target vessel revascularization [10].

Aim

The aim of our study was to compare safety and efficacy of the Luc Chopin^2 stent (Balton Ltd, Warsaw, Poland) eluting paclitaxel from biodegradable polymer with the durable polymer Taxus Liberté stent (Boston Scientific, Maple Grove, Minnesota).

Material and methods

Study design and patient population

The trial was a two-center randomized assessor-blind study with angiographic and intravascular ultrasound (IVUS) follow-up. The study protocol is registered on the ClinicalTrials.gov website (NCT00766129). All eligible patients were randomized 1 : 1 either to the Taxus Liberté group or to the Luc Chopin^2 group. Sealed envelopes with names of study groups, prepared beforehand, were used for randomization. The study was approved by the local Ethics Committee and was performed in accordance with the Helsinki II Declaration. All patients participating in the trial signed informed consent. We included consecutive patients with stable coronary artery disease or non-ST segment elevation acute coronary syndrome with culprit de-novo lesions in saphenous vein grafts causing angiographic stenosis assessed by visual estimation as ≥ 70%. The reference segment diameter had to be in the range of 2.5-4.5 mm. The exclusion criteria were: cardiogenic shock, contraindications to prolonged dual antiplatelet therapy, female of child birth potential unless on effective contraception, and any other medical condition that could limit survival.

Tested device and protocol-related procedures

The Luc-Chopin^2 stent (Balton Ltd, Warszawa, Poland), commercially available in Europe, elutes paclitaxel from a biodegradable co-polymer of lactic and glycolic acid with a short lifetime. The paclitaxel dose in the Luc Chopin^2 stent is 1.0 µg/mm^2 (the same drug concentration as in the Taxus Liberté stent). The platform for the Luc Chopin^2 device is a stainless steel Chopin^2 stent that was reported previously [11]. The drug delivery and subsequent complete polymer resorption lasts around 8 weeks. The Luc Chopin^2 stent was found safe and effective in restenosis reduction in preclinical studies and in human native coronary arteries [12, 13].

To ensure optimal stent implantation baseline PCI procedures on the target SVG lesions were planned to be done under IVUS guidance in all randomized patients. After PCI all patients were prescribed aspirin and clopidogrel for at least 12 months. Repeat coronary angiography and IVUS examination were planned 9 months after the index procedure. All IVUS examinations were performed after 0.2 mg of nitroglycerine administered intracoronary and heparin bolus (100 U/kg) given intravenously. The commercially available IVUS catheter (Volcano Corporation, San Diego, California, USA or Boston Scientific Fremont, CA, USA) was advanced > 10 mm distally to the stented segment, and imaging was performed retrogradely to the aorto-ostial junction with an automatic pullback (0.5 mm/s).

Study endpoints

The primary endpoint was neointima hyperplasia (NIH) volume measured with intravascular ultrasound 9 months after stent implantation. The secondary endpoint was late lumen loss assessed angiographically at 9-month follow-up. The scheduled time frame for safety endpoint assessment is 5 years and these results will be presented in a separate report.

Table 1. Baseline demographic and clinical characteristics
Tabela 1. *Wyjściowa charakterystyka demograficzna i kliniczna pacjentów*

Parameter	Taxus Liberté group (26 patients)	Luc Chopin² group (25 patients)	Value of *p*
Male, *n*	22	24	0.37
Age, mean ± SD [years]	72 ±9	67 ±9	0.06
Stable angina, *n*	19	24	0.06
Graft age, mean ± SD [years]	13.5 ±5.2	11.2 ±5.7	0.17
Previous myocardial infarction, *n*	17	15	0.90
Previous percutaneous coronary intervention, *n*	8	12	0.33
Diabetes mellitus, *n*	8	8	0.83
Hypercholesterolemia, *n*	26	25	1.0
Hypertension, *n*	22	21	0.75

Intravascular ultrasound and angiographic off-line analyses

Off-line quantitative IVUS analyses were performed by an experienced observer (JP) blinded to patients' allocation to study groups, according to the criteria of the American College of Cardiology Clinical Expert Consensus Document on IVUS [14]. Lumen, stent, and external elastic membrane cross-sectional areas (CSAs) were measured every millimeter of the stented segment. Neointima hyperplasia was calculated as stent minus lumen measures at follow-up examination. The respective volumes were calculated according to Simpson's rule. Percent neointima volume was defined as follows: (NIH volume divided by the stent volume) 100×. Proximal and distal stent edges for which volumetric measurements were also produced were defined as 5 mm long segments located within the stent and adjacent to its border.

Baseline and follow-up angiograms (AXIOM ARTIS DFC, Siemens, Forchheim, Germany) were analyzed off-line using quantitative coronary angiography (QCA) by an experienced observer (LK) blinded to patients' allocation to study groups. References were the most normal looking segments located within 10 mm from the lesion site. Baseline angiogram measurements included lesion length, minimal lumen diameter prior to stent implantation and minimal in stent lumen diameter immediately after PCI as well as lumen diameters at proximal and distal reference sites. In follow-up angiograms minimal in stent lumen diameter was measured. Late loss was defined as the difference between minimal lumen diameter in the angiogram obtained after stent implantation and at the 9-month follow-up.

Statistical analysis

At the time of planning our study there were scarce data on the efficacy of DES in SVG lesions. Therefore our trial was designed as a pilot study without sample size calculations. Continuous data with normal distribution are presented as means with standard deviation. An independent samples T-test, paired T-test, Mann-Whitney test, or Wilcoxon test was used to assess differences between continuous variables. Categorical variables were compared with the χ^2 are test. We used MedCalc version 9.3.8.0 (Mariekerke, Belgium) for statistical analysis.

Results

Between January 2008 and April 2011 we enrolled 51 patients. Baseline clinical, demographic, angiographic and procedural characteristics were similar in both study arms (Table 1). Twenty-six patients were randomized to the Taxus Liberté group and 25 patients to the Luc Chopin² group. Percutaneous coronary intervention was performed in 55 separate lesions in 52 SVGs. Taxus Liberté stents were implanted in 28 lesions and in 25 lesions Luc Chopin² stents were used. In 2 patients randomized to the Luc Chopin² group the assigned stent could not be delivered; in one of these subjects only balloon angioplasty was performed and in the other a bare metal stent was implanted. During 9-month follow-up 2 patients from the Taxus Liberté group died (1 sudden cardiac death and 1 presumably due to the exacerbation of congestive heart failure) while there were no deaths in the Luc Chopin² group ($p = 0.45$). One of the 2 deaths that occurred in the Taxus group was classified as a possible stent thrombosis case according to the ARC definitions [15]. There were no angiographically documented cases of stent thrombosis or myocardial infarction in either study arm. Target lesion revascularization was performed in 5 patients from the Luc Chopin² group and in 1 patient from the Taxus group ($p = 0.21$). In 2 patients the restenosis was symptomatic and in the remaining cases it was clinically silent and identified at scheduled angiographic follow-up. Overall, there were 5 major adverse cardiac events in the Luc Chopin² group and 3 in the Taxus group ($p = 0.75$).

The scheduled control angiography was performed for 45 lesions in 41 patients because 5 patients refused to undergo the scheduled procedure and one patient was lost to follow-up (Fig. 1). In 2 patients who did not receive the study stent the invasive follow-up was deferred and

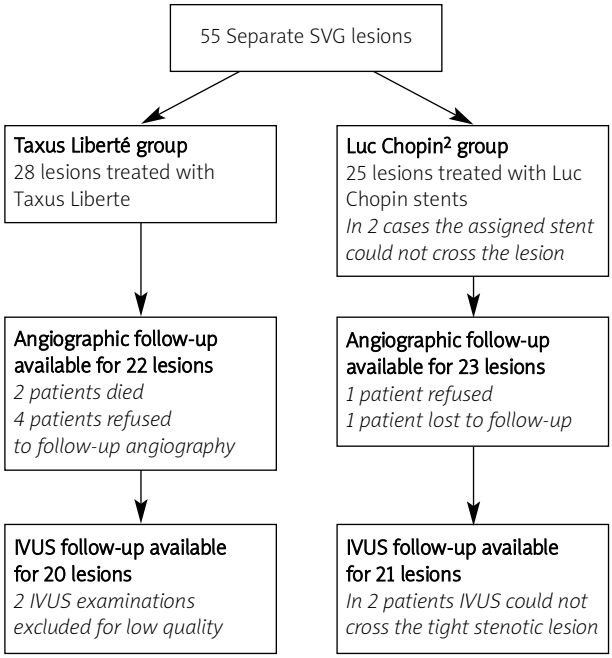

Fig. 1. Flow diagram of the study
Ryc. 1. *Schemat udziału pacjentów w badaniu*

only clinical observation was continued and analyzed on the intention to treat basis. Angiographic minimal in stent lumen diameter was similar in both study arms (Table 2). However, late lumen loss was larger in the Luc Chopin^2 group (0.59 ±0.74 mm vs. 0.30 ±0.81 mm; p = 0.015), mainly due to the greater number of restenotic lesions in the Luc Chopin^2 arm. Follow-up IVUS examination was available in 37 patients (41 lesions), because in 4 cases the IVUS catheter could not cross the restenotic lesion or the image quality was low (Fig. 1). The proportion of lesions without IVUS detectable neointimal growth within the stented segment at follow-up examination was similar in Taxus Liberté and Luc Chopin^2 arms (30% vs. 29%; p = 0.90). There was a trend towards larger NIH volume (primary outcome measure) in Luc Chopin^2 stents (15.8 ±14.5 mm^3 vs. 11.9 ±29.4 mm^3; p = 0.1). Also, we observed a similar tendency with regards to larger percent neointima volume within stents with biodegradable vs. durable polymer (12.6 ±11.5% vs. 7.8 ±16.5%; p = 0.08 respectively).There was a significant difference in the distribution of the restenotic tissue within the stented segment with more neointimal hyperplasia in its proximal part in the Luc Chopin^2 group (6.3 ±6.1 mm^3 vs. 4.7 ±15.5 mm^3; p = 0.001) (Table 3). Also the length of the stented segment covered with detectable neointima tended to be longer in lesions treated with Luc Chopin^2 stents (31 ±32% vs. 18 ±22%; p = 0.13). Evaluating only stents with detectable neointima, 25 ±22% of the stent length in the Taxus stents compared with 47 ±28% in the Luc Chopin^2 stents was covered (p = 0.04).

Discussion

To the best of our knowledge the current manuscript is the first report on the comparison of paclitaxel-eluting

Table 2. Baseline and follow-up procedural and quantitative coronary angiography lesion characteristics
Tabela 2. *Angiograficzna charakterystyka leczonych zwężeń. Parametry wyjściowe i pochodzące z obserwacji*

Variable	Taxus Liberté group	Luc Chopin² group	Value of *p*
Baseline	**28 lesions**	**27 lesions**	
Procedural variables			
SVG-LAD, *n*	11	11	0.50
SVG-LCX, *n*	10	12	
SVG-RCA, *n*	5	3	
Jumping graft, *n*	2	1	
Nominal stent diameter [mm]	3.45 ±0.48	3.46 ±0.59	0.94
Stent length [mm]	17.2 ±5.2	17.6 ±9.2	0.85
Baseline angiographic data			
Lesion length [mm]	15.2 ±4.4	15.4 ±9.5	0.94
Minimal lumen diameter [mm]	0.90 ±0.57	1.10 ±0.61	0.25
Proximal reference lumen diameter [mm]	2.94 ±0.55	3.02 ±0.71	0.66
Distal reference lumen diameter [mm]	3.00 ±0.59	3.13 ±0.73	0.50
Minimal in stent lumen diameter after stent implantation [mm]	2.86 ±0.68	3.0 ±0.63	0.51
Follow-up angiographic data	**22 lesions**	**23 lesions**	
Minimal in stent lumen diameter at follow-up [mm]	2.50 ±0.63	2.25 ±0.76	0.23
Late loss [mm]	0.30 ±0.81	0.59 ±0.74	0.015

SVG – saphenous vein graft, LAD – left anterior descending, LCX – left circumflex, RCA – right coronary artery
SVG – pomost żylny, LAD – gałąź przednia zstępująca, LCX – gałąź okalająca, RCA – prawa tętnica wieńcowa

Table 3. Follow-up IVUS measurements
Tabela 3. *Pomiary IVUS wykonane po 9 miesiącach od implantacji stentu*

Variable	Taxus Liberté group (20 lesions)	Luc Chopin^2 group (21 lesions)	Value of *p*
Neointimal hyperplasia volume* [mm^3]	11.9 ±29.4	15.8 ±14.5	0.1
Percent neointima volume [%]	7.8 ±16.5	12.6 ±11.5	0.08
Neointimal length [mm]	3.0 ±3.8	5.2 ±4.7	0.10
Stent volume [mm^3]	131.5 ±55.0	151.7 ±87.8	0.57
Lumen volume [mm^3]	114.8 ±58.4	134.4 ±82.6	0.39
Vessel volume [mm^3]	265.4 ±95.5	285.7 ±147.8	0.61
Proximal edge neointimal hyperplasia volume [mm^3]	4.7 ±15.5	6.3 ±6.1	0.001
Distal edge neointimal hyperplasia volume [mm^3]	4.5 ±14.0	4.4 ±5.7	0.14

**Primary outcome measure*
**Pierwszorzędowy punkt końcowy*

stents with biodegradable versus stable polymer implanted in SVGs. The main findings of the study are as follows: (1) short-term safety of paclitaxel-eluting stents with biodegradable and durable polymer implanted into SVG lesions is similar, (2) paclitaxel-eluting stents with biodegradable polymer seem to be less effective in angiographically assessed inhibition of neointimal hyperplasia in SVGs.

There are relatively sparse data on safety and efficacy of DES implanted into SVGs [15, 16]. Our report showing good 9-month clinical and angiographic follow-up after implantation of DES into SVG stenosis is in line with the results of the ISAR-CABG study and with short-term observations from the RRISC and SOS trials [16-18].

Biodegradable polymer DES were designed to reduce long-term adverse events related to the presence of durable polymers after completion of drug release. This concept was validated by the results of the LEADERS study showing similar effectiveness and a better long-term safety profile of stents with biodegradable polymer eluting Biolimus as compared with stents eluting sirolimus from durable polymer [18, 19]. In our study there was a greater number of patients with target lesion revascularization in the group treated with stents eluting a drug from biodegradable polymer, which suggests lower efficacy of the Luc Chopin^2 device despite the same concentration of paclitaxel on the surface of both stent types. Nevertheless, we did not observe a significant difference in the primary endpoint of the study, neointima volume, between the study arms. The lack of significant difference in the neointima volume may be partially related to the inability to cross 2 tight restenotic Luc Chopin^2 lesions with the IVUS catheter – no data on presumably large intima volume was therefore available for those 2 stents. Interestingly, the axial distribution pattern suggested a more diffuse process of neointima formation within stents with biodegradable polymer. The results of QCA angiographic analyses showing late loss of 0.59 mm in Luc Chopin^2 stents are similar to the performance of this device in the animal model (late loss of 0.52 mm in pigs) and are slightly worse than in native human coronary arteries (late loss of 0.4 mm in lesions treated with the Luc Chopin^2 stent) [12, 13]. The significantly larger angiographic late loss with the Luc Chopin^2 stents is in line with the results of the COSTAR II study in which stents eluting paclitaxel from biodegradable polymer had larger late loss when tested against durable polymer Taxus stents [10]. Of note, both in Luc Chopin^2 and in CoStar stents the same polylactic-co-glycolic polymer was used. Therefore, it is possible that the lower efficacy of these stents may be associated with the ineffective pharmacokinetic release of paclitaxel from the specific biodegradable polymer. In the LEADERS study documenting benefits associated with biodegradable polymer not only the cytotoxic drug (Biolimus) but also the polymer was different than in CoStar and Luc Chopin^2 stents [19, 20].

Our study was obviously underpowered to detect a difference in the clinical outcome. Therefore, we may only speculate that 2 deaths (one possible stent thrombosis) in the Taxus group, as compared with survival of all patients from the Luc Chopin^2 arm, may be associated with an adverse reaction to the durable polymer.

The major limitation of our study is the small number of patients. Angiographic and IVUS follow-up was available for only around 80% of the enrolled population.

Conclusions

Luc Chopin^2 stents eluting paclitaxel from biodegradable polylactic-co-glycolic polymer implanted into SVGs seem to be less effective in inhibition of neointimal proliferation than durable polymer Taxus stents during 9-month follow-up. Whether the possible clinical benefits associated with polymer resorption may outweigh the risk of restenosis related to increased neointima proliferation needs to be established in a larger study with longer clinical follow-up.

References

1. Morice MC, Serruys PW, Sousa JE, et al. A randomized comparison of a sirolimus-eluting stent with a standard stent for coronary revascularization. N Engl J Med 2002; 346: 1773-1780.
2. Moses JW, Leon MB, Popma JJ, et al. Sirolimus-eluting stents versus standard stents in patients with stenosis in a native coronary artery. N Engl J Med 2003; 349: 1315-1323.
3. Stone GW, Ellis SG, Cox DA, et al. A polymer-based, paclitaxel-eluting stent in patients with coronary artery disease. N Engl J Med 2004; 350: 221-231.
4. Colombo A, Drzewiecki J, Banning A, et al. Randomized study to assess the effectiveness of slow- and moderate-release polymer-based paclitaxel-eluting stents for coronary artery lesions. Circulation 2003; 108: 788-794.
5. Stone GW, Moses JW, Ellis SG, et al. Safety and efficacy of sirolimus- and paclitaxel-eluting coronary stents. N Engl J Med 2007; 356: 998-1008.
6. Brilakis ES, Wang TY, Rao SV, et al. Frequency and predictors of drug-eluting stent use in saphenous vein bypass graft percutaneous coronary interventions: a report from the American College of Cardiology National Cardiovascular Data CathPCI registry. JACC Cardiovasc Interv 2010; 3: 1068-1073.
7. Mamas MA, Foley J, Nair S, et al. A comparison of drug-eluting stents versus bare metal stents in saphenous vein graft PCI outcomes: a meta-analysis. J Interv Cardiol 2011; 24: 172-180.
8. Kastrati A, Mehilli J, Pache J, et al. Analysis of 14 trials comparing sirolimus-eluting stents with bare-metal stents. N Engl J Med 2007; 356: 1030-1039.
9. Vermeersch P, Agostoni P, Verheye S, et al. Increased late mortality after sirolimus-eluting stents versus bare-metal stents in diseased saphenous vein grafts: results from the randomized DELAYED RRISC Trial. J Am Coll Cardiol 2007; 50: 261-267.
10. Krucoff MW, Kereiakes DJ, Petersen JL, et al. COSTAR II Investigators Group. A novel bioresorbable polymer paclitaxel-eluting stent for the treatment of single and multivessel coronary disease: primary results of the COSTAR (Cobalt Chromium Stent With Antiproliferative for Restenosis) II study. J Am Coll Cardiol 2008; 51: 1543-1552.
11. Buszman P, Zurakowski A, Kinasz L, et al. The new Polish stent Chopin. Assessment of safety and efficacy in the treatment of de-novo coronary lesions using percutaneous angioplasty. Kardiol Pol 2005; 62: 451-459.
12. Buszman P, Trznadel S, Milewski K, et al. Novel paclitaxel-eluting, biodegradable polymer coated stent in the treatment of de novo coronary lesions: a prospective multicenter registry. Catheter Cardiovasc Interv 2008; 71: 51-57.
13. Buszman P, Milewski K, Zurakowski A, et al. Novel biodegradable polymer-coated, paclitaxel-eluting stent inhibits neointimal formation in porcine coronary arteries. Kardiol Pol 2010; 68: 503-509.
14. Mintz GS, Nissen SE, Anderson WD, et al. ACC clinical expert consensus document on standards for the acquisition, measurement and reporting of intravascular ultra-sound studies: a report of the American College of Cardiology Task Force on Clinical Expert Consensus Documents (Committee to Develop a Clinical Expert Consensus Document on Standards for Acquisition, Measurement and Reporting of Intravascular Ultrasound Studies [IVUS]). J Am Coll Cardiol 2001; 37: 1478-1492.
15. Cutlip DE, Windecker S, Mehran R, et al. Academic Research Consortium. Clinical end points in coronary stent trials: a case for standardized definitions. Circulation 2007; 115: 2344-2351.
16. Mehilli J, Pache J, Abdel-Wahab M, et al.; (ISAR-CABG) Investigators. A drug-eluting versus bare-metal stents in saphenous vein graft lesions (ISAR-CABG): a randomised controlled superiority trial. Is Drug-Eluting-Stenting Associated with Improved Results in Coronary Artery Bypass Grafts? Lancet 2011; 378: 1071-1078.
17. Vermeersch P, Agostoni P, Verheye S, et al. Randomized double-blind comparison of sirolimus-eluting stent versus bare-metal stent implantation in diseased saphenous vein grafts: six-month angiographic, intravascular ultrasound, and clinical follow-up of the RRISC Trial. J Am Coll Cardiol 2006; 48: 2423-2431.
18. Brilakis ES, Lichtenwalter C, de Lemos JA, et al. A randomized controlled trial of a paclitaxel-eluting stent versus a similar bare-metal stent in saphenous vein graft lesions the SOS (Stenting of Saphenous Vein Grafts) trial. J Am Coll Cardiol 2009; 53: 919-928.
19. Windecker S, Serruys PW, Wandel S, et al. Biolimus-eluting stent with biodegradable polymer versus sirolimus-eluting stent with durable polymer for coronary revascularisation (LEADERS): a randomised non-inferiority trial. Lancet 2008; 372: 1163-1173.
20. Stefanini GG, Kalesan B, Serruys PW, et al. Long-term clinical outcomes of biodegradable polymer biolimus-eluting stents versus durable polymer sirolimus-eluting stents in patients with coronary artery disease (LEADERS): 4 year follow-up of a randomised non-inferiority trial. Lancet 2011; 378: 1940-1948.