Adverse cardiovascular events associated with biodegradable polymer drug-eluting stents and durable polymer everolimus-eluting stents
A systematic review and meta-analysis of 10 randomized controlled trials

Pravesh Kumar Bundhun, MDa, Girish Janoo, MBBSb, Chandra Mouli Yanamala, MDC, Feng Huang, MDb,∗

Abstract

Background: Controversies have been observed among network meta-analyses comparing biodegradable polymer drug-eluting stents (BP-DES) with durable polymer drug-eluting stents (DP-DES). We aimed to compare the adverse cardiovascular events associated with BP-DES and durable polymer everolimus-eluting stents (DP-EES) using a large number of patients obtained from randomized controlled trials (RCTs).

Methods: Electronic databases were searched for randomized trials comparing BP-DES with DP-EES. Adverse cardiovascular outcomes observed between 6 months and 3 years were considered as the clinical endpoints in this analysis. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated and the pooled analyses were performed with RevMan 5.3 software. All authors had full access to the data, and they have read and agreed to the manuscript as written.

Results: Ten trials involving a total number of 13,218 patients (7451 patients treated by BP-DES and 5767 patients treated by DP-EES) were included. No significant difference was observed when analyzing mortality and myocardial infarction between BP-DES and DP-EES with OR 1.09, 95% CI 0.87–1.34; P = .72 respectively. Target vessel revascularization, target lesion revascularization, major adverse cardiac events, and stroke were also not significantly different with OR 1.11, 95% CI 0.92–1.33; OR 1.16, 95% CI 0.93–1.44; OR 1.19, 95% CI 0.96–1.48; P = .28; OR 1.11, 95% CI 0.94–1.33; P = .22; OR 1.12, 95% CI 0.99–1.27; P =.07; and OR 1.13, 95% CI 0.69–1.84; P = .62 respectively. In addition, total stent thrombosis (ST) was similarly reported between BP-DES and DP-EES with OR 0.85, 95% CI 0.59–1.21; P = .37. However, even if BP-DES were associated with a higher rate of definite ST with OR 1.69, 95% CI 0.92–3.08, P = .09 and DP-EES were associated with a higher rate of probable ST with OR 0.67, 95% CI 0.38–1.17, P = .16, these results were not statistically significant.

Conclusions: Between 6 months and 3 years, BP-DES were similar in terms of cardiovascular outcomes compared to DP-EES. However, further long-term follow-up research is recommended.

Abbreviations: BP-DES = biodegradable polymer drug-eluting stents, CAD = coronary artery disease, DP-EES = durable polymer everolimus-eluting stents, MACEs = major adverse cardiac events, PCI = percutaneous coronary intervention, RCTs = randomized controlled trials, ST = stent thrombosis.

Keywords: biodegradable polymer drug-eluting stents, cardiovascular events, coronary artery diseases, durable polymer everolimus-eluting stents, percutaneous coronary intervention, randomized controlled trials, stent thrombosis

1. Introduction

Controversies have been observed among network meta-analyses comparing biodegradable polymer drug-eluting stents (BP-DES) with durable polymer drug-eluting stents (DP-DES). To be more precise, the Bayesian approach network meta-analysis comparing BP-DES with bare metal stents (BMS) and DP-DES, respectively, in patients undergoing coronary revascularization showed durable polymer everolimus-eluting stents (DP-EES) to be safer than biodegradable polymer biolimus-eluting stents (BP-BES) at 1-year follow-up.[1] BP-BES were associated with a higher risk of stent thrombosis (ST) compared to DP-EES. Another example is the comprehensive network meta-analysis, which aimed to investigate the efficacy and safety of BP-BES with DP-DES using data from 60 randomized controlled trials (RCTs), which showed that even if BP-BES and DP-EES were equally effective, DP-EES were considered safer than BP-BES.[2] In addition, the mixed treatment comparison meta-analysis comparing BP-DES with DP-DES showed DP-EES to be the most effective and safest DES[3] compared to the other DES analyzed. However, the
authors also concluded that the utility of BP-DES in the context of excellent adverse clinical outcomes with newer-generation DP-DES for example DP-EES needed to be further confirmed in future studies. Hence, we aimed to compare the adverse cardiovascular events associated with the implantation of BP-DES and DP-EES during a mean follow-up period ranging from 6 months to 3 years, using a large number of patients obtained from randomized trials.

2. Methods

2.1. Data sources and search strategy

The Cochrane Library, PubMed/Medline, and EMBASE databases were searched for trials comparing BP-DES with DP-EES by typing terms such as “Biodegradable and durable drug eluting stents.” Abbreviations such as “DES and EES” were also used. Moreover, the words “durable DES” were also replaced by the words “permanent DES” and another search was carried out. In addition, reference lists of suitable studies were also checked for relevant trials. To ensure a better search, official websites of several well-known journals related to Cardiology such as the Journal of the American College of Cardiology and Circulation were also searched for any new or missing trial. Only articles published in English were considered and this search process was terminated by the end of March 2016.

2.2. Inclusion and exclusion criteria

Studies were included if:

(a) They were RCTs comparing BP-DES with DP-EES.
(b) They reported adverse cardiovascular outcomes as their clinical endpoints.
(c) They had a follow-up period of ≥6 months.

Studies were excluded if:

(a) They were non-RCTs (observational studies, meta-analyses, case studies, letter to editors).
(b) They did not compare BP-DES with DP-EES.
(c) They did not report adverse cardiovascular outcomes.
(d) They had a follow-up period of <6 months.
(e) They were duplicates or they were associated with the same trial.

2.3. Outcomes, definitions, and follow-up

Adverse cardiovascular outcomes were considered as the clinical endpoints in this meta-analysis. They included:

(a) All-cause mortality (cardiac and noncardiac death)
(b) Myocardial infarction (MI)
(c) Target vessel revascularization (TVR)
(d) Target lesion revascularization (TLR)
(e) Stroke
(f) Major adverse cardiac events (MACEs) consisting of death, MI, and revascularization (TVR and TLR).
(g) ST which was defined according to the Academic Research Consortium (ARC) and involved definite ST, probable ST, and total ST (definite and probable).

This analysis had a mean follow-up period ranging from 6 months to 3 years. One trial had a follow-up period of 6 months, 2 years, and 3 years, respectively, whereas 7 trials had a follow-up period of 1 year (Table 1).

2.4. Data extraction and quality assessment

Three authors (PKB, GJ, and CMY) independently reviewed and assessed the methodological quality of each trial, which was considered eligible for this systematic review and meta-analysis. Information and data concerning the trial name, trial unique identifier number, total number of patients randomized to BD DES and DP-EES, respectively, patients’ enrollment periods, data concerning the baseline characteristics of the patients included, the clinical endpoints reported as well as the follow-up periods of each eligible trial were carefully extracted. Disagreements were solved by the third author (FH). The bias risk was assessed by the authors in accordance to the recommendations by the Cochrane Collaboration and grades were allocated accordingly to these trials. Trials were allocated a grade “A” if a very low risk of bias was reported, a grade “B” if a low risk of bias was noted, a grade “C” if a moderate risk of bias was observed, and a grade “D” if a high risk of bias was noted. The authors tried to be fair enough during this assessment/grading process. Bias grades have been listed in Table 2.

2.5. Methodological and statistical analysis

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was followed for this systematic

| Table 1 | Reported outcomes and follow-up periods. |
|---------|----------------------------------------|
| Trials  | Outcomes reported                      | Follow-up periods | Duration of DAPT use          |
| BIOPLOW II | Death, MI, TLR, TVR, definite ST, probable ST | 1 y | ASA + clopidogrel for ≥6 mo |
| BIOSCIENCE | Death, MI, TLR, TVR, stroke, probable ST, definite ST, BARC bleeding | 1 y | ASA + clopidogrel or prasugrel or ticagrelor for 12 mo |
| CENTURY II | Death, MI, TLR | 2 y | ASA + clopidogrel for at least 6 mo |
| COMPARE II | Death, MI, TVR, TL, definite and probable ST | 1 y | ASA + clopidogrel or prasugrel for 12 mo |
| ISAR TEST 4 | Death, TLR, definite and probable ST | 3 y | — |
| EVOLVE | Death, MI, TLR, TVR, definite and probable ST | 6 mo | ASA + clopidogrel for 6 to 12 mo |
| NEXT | Death, MI, TLR, TVR, stroke, MACEs, definite and probable ST, TIMI defined bleeding | 1 y | ASA + clopidogrel or ticagrelor for 3 mo |
| TARGET I | Death, MI, TLR, probable or definite ST | 1 y | ASA + clopidogrel for 12 mo |
| Sepharham | MACEs, cardiac death, MI, TVR, ST | 1 y | ASA + clopidogrel for 12 mo |
| EVOLVE II | Death, MI, TVR, probable or definite ST | 1 y | ASA + clopidogrel for 6 to 12 mo |

ASA = aspirin, BARC = bleeding academic research consortium, DAPT = dual anti-platelet therapy, MACEs = major adverse cardiac events, MI = myocardial infarction, ST = stent thrombosis, TIMI = thrombolysis in myocardial infarction, TVR = target vessel revascularization, TLR = target lesion revascularization.
review and meta-analysis of randomized trials. Heterogeneity among the subgroups analyzing adverse cardiovascular events was assessed using the Cochrane Q-statistic and the $I^2$ statistic tests. In this analysis, a $P$ value $\leq 0.05$ was considered statistically significant, whereas a $P$ value $> 0.05$ was considered statistically insignificant. In addition, a very low heterogeneity was indicated by an $I^2$ value of 0%, whereas larger values of $I^2$ indicated increased heterogeneity. A fixed or random effect model was used depending on the value of $I^2$ obtained. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated appropriately and the analyses were conducted with RevMan 5.3 software. All authors had full access to the data included in this analysis, and they have read and agreed to the manuscript as written.

Sensitivity analysis was conducted by excluding these trials one by one and performing another analysis to observe any significant changes in the results obtained.

2.6. Publication bias assessment
Funnel plots obtained from Revman were used to visually observe any publication bias. As this analysis involved only 10 trials (which was considered a smaller volume of trials), funnel plots were considered relevant enough to assess publication bias.

2.7. Ethics approval and patients consent
Ethical approval and patient consents were not necessary for systematic reviews and meta-analyses.

3. Results

3.1. Search results
A total number of 742 articles were obtained from the Cochrane Library, PubMed/Medline, and EMBASE databases, as well as from the reference lists of suitable articles and from official websites of well-known cardiology journals. After a careful assessment of the titles and abstracts, 699 articles were eliminated as they were either not related to the topic of this research or they were duplicates. A total of 43 full-text articles were assessed for eligibility. After reviewing the full-text articles, further articles were eliminated since: 7 articles were meta-analyses, 3 articles were letter to editors, and 6 articles were observational studies. In addition, 15 more articles were eliminated as they compared BP-DES with either durable polymer sirolimus-eluting stents, or durable polymer paclitaxel-eluting stents. Another 2 articles were eliminated as one was a design of a trial, whereas the other was associated with the same trial. Finally, 10 trials[7–16] were selected for this analysis. This study selection process has been represented in Fig. 1.

3.2. General features of the trials included
A total number of 13,218 patients (7451 patients treated by BP-DES and 5767 patients treated by DP-EES) were included. The types of BP-DES involved, the unique identifier as well as the journal in which these trials were published have been listed in Table 2, whereas Table 3 summarized the patients’ enrollment periods, and listed the total number of patients treated with BP-DES and DP-EES, respectively.

| Trials   | Types of BP-DES versus DP-EES | Unique identifier | Journal published | Bias risk Grade |
|----------|--------------------------------|-------------------|-------------------|----------------|
| BIOFLOW[7] | BP-SES vs. DP-EES | NCT01356888 | Circulation | B |
| BIOSCIENCE[8] | BP-SES vs. DP-EES | NCT01443104 | The Lancet | B |
| CENTURY III[9] | BP-SES vs. DP-EES | UMIN000006940 | JACC | B |
| COMPARE II[10] | BP-SES vs. DP-EES | NCT01233453 | The Lancet | B |
| ISAR TEST II[11] | BP-DES vs. DP-EES | NCT00598676 | JACC | B |
| EVOLVE[12] | BP-EES vs. DP-EES | NCT01135225 | JACC | B |
| NEXT[13] | BP-BES vs. DP-EES | NCT01303640 | JACC | B |
| TARGET I[14] | BP-DES vs. DP-EES | NCT01196819 | JCTS | B |
| Sepahram[15] | BP-DES vs. DP-EES | NCT01665053 | Circulation | B |

BP-DES = biodegradable polymer biolimus-eluting stents, BP-DES = biodegradable polymer drug-eluting stents, BP-EES = biodegradable polymer everolimus-eluting stents, BP-SES = biodegradable polymer sirolimus-eluting stents, BP = biodegradable polymer, CRM = cardiovascular revascularization medicine, DP-EES = durable polymer everolimus-eluting stents, DP = durable polymer, JACC = Journal of American College of Cardiology, JCTS = Journal of cardiovascular and thoracic surgery.
3.3. Baseline features of the trials included

The baseline characteristics of the patients have been summarized in Table 4.

Trial CENTURY II consisted of the majority of patients who were males. Trial NEXT had the highest number of patients with hypertension and diabetes mellitus, respectively. The percentage of patients with dyslipidemia varied considerably among the different trials. For example, NEXT trial showed a high percentage of patients with dyslipidemia in both groups, whereas TARGET I trial showed a very low percentage of patients with dyslipidemia, which could have been because of early treatment with statin or a decrease in the level of high-density lipoprotein. According to Table 4, there were no significant differences in baseline features among patients randomized to either the BP-DES or DP-EES group.

3.4. Comparing the adverse cardiovascular events associated with BP-DES and DP-EES

Results of this analysis showed that no significant difference in mortality and MI between BP-DES and DP-EES with OR 1.08, 95% CI 0.84–1.33, P = .22, I² = 0%; OR 1.12, 95% CI 0.99–1.27, P = .07, I² = 0%; and OR 1.13, 95% CI 0.69–1.84, P = .62, I² = 6%, respectively. These results have been represented in Fig. 3.

3.5. Comparing ST associated with BP-DES versus DP-EES

Total ST (definite + probable) was not significantly different between BP-DES and DP-EES with OR 0.85, 95% CI 0.59–1.21, P = .37, I² = 0%. BP-DES were associated with a higher rate of definite ST with OR 1.69, 95% CI 0.92–3.08, P = .09, I² = 0%. However, probable ST was higher in the DP-EES group with OR 0.67, 95% CI 0.38–1.17, P = .16, I² = 39%. However, in both cases, the results were not statistically significant. These results have been represented in Fig. 4.

3.6. Comparing BP-SES with DP-EES

This further analysis comparing BP-SES with DP-EES also did not show any significant difference between BP-SES and DP-EES among all the clinical outcomes analyzed. Mortality, MI, TVR, TLR, and MACEs were not significantly different with OR 1.19, 95% CI 0.74–1.91, P = .48, I² = 0%; OR 0.88, 95% CI 0.60–1.28, P = .51, I² = 0%; OR 1.17, 95% CI 0.83–1.65, P = .37, I² = 7%; OR 1.18, 95% CI 0.80–1.95, P = .41, I² = 0%; and OR 1.10, 95% CI 0.90–1.35, P = .36, I² = 0%, respectively.
ST was also not significantly different between these 2 types of stents. Results comparing BP-SES with DP-EES have been represented in Fig. 5.

3.7. Comparing BP-BES with DP-EES

When BP-BES were separately compared with DP-EES, no significant differences were observed in mortality, MI, TVR, TLR, and MACEs with OR 1.11, 95% CI 0.77–1.62, \( P = .57 \), \( I^2 = 0\% \); OR 1.11, 95% CI 0.82–1.51, \( P = .49 \), \( I^2 = 0\% \); OR 1.11, 95% CI 0.87–1.41, \( P = .39 \), \( I^2 = 0\% \); OR 1.05, 95% CI 0.79–1.39, \( P = .76 \), \( I^2 = 0\% \); and OR 1.15, 95% CI 0.95–1.39, \( P = .16 \), \( I^2 = 0\% \), respectively. Even the results for ST were not significantly different. Results comparing BP-BES with DP-EES have been represented in Fig. 6.

Results of this analysis have been listed in Table 5.

For all of the above analyses, sensitivity analyses yielded consistent results. Except for the fact that when certain trials were excluded and the analysis was carried out, results for MACEs only reached statistical significance, but were not statistically significant. When BIOFLOW II trial was excluded and an analysis was performed, MACEs favored DP-EES and the result reached statistical with OR 1.14, 95% CI 1.00–1.29, \( P = .05 \). However, exclusion of other trials did not affect the results.

Based on a visual inspection of the funnel plots obtained, there has been very little evidence of publication bias among the trials that assessed all clinical and cardiovascular endpoints (mortality, MI, TVR, TLR, MACEs, stroke, and ST). The funnel plots showing publication bias have been illustrated in Figs. 7A–D.

4. Discussion

This analysis aimed to compare BP-DES with DP-EES in patients with coronary artery diseases (CADs). The results of this analysis showed that BP-DES were noninferior to DP-EES in terms of adverse cardiovascular events. BP-DES and DP-EES were associated with similar rates of mortality, MI, MACEs, stroke, and ST. The funnel plots showing publication bias have been illustrated in Figs. 7A–D.
subgroup. Even when BP-SES and BP-BES were separately compared with DP-EES, no significant difference was observed in the results.

Similar to the results of this current analysis, another meta-analysis comparing BP-DES with DP-EES and involving only 4 trials with a total number of 8282 patients showed that BP-DES were noninferior to DP-EES in terms of MACEs and ST.[17] Moreover, the observational study including a total number of 707 consecutive patients with ST segment elevated MI also showed BP-DES to report similar adverse outcomes compared to DP-EES during a follow-up period of 2 years.[18] Another study involving data from the Korea Acute Myocardial Infarction...
Registry (KAMIR) including a total number of 3359 patients with acute MI showed BP-SES to be noninferior to second-generation DP-DES during a follow-up of 2 years.\(^{[19]}\) Recently, even Pandya et al.\(^{[20]}\) showed no significant differences between BP-DES and second generation DP-DES. However, their meta-analysis not only included DP-EES, but also included DP-ZES and the patients were followed up for a mean time period of 16 months only.

In addition, the meta-analysis of randomized trials comparing the effectiveness and safety between BP-DES and DP-DES showed no significant reduction in MACEs with the use of BP-DES.\(^{[21]}\) However, a significantly lower risk of late ST was observed in the BP-DES group when compared to DP-DES. Note that among 8 trials which were included, 3 trials involved DP-EES. Also, the study comparing absorbable polymer sirolimus-eluting stents (MiStent) to the DP-EES using patients from the DESSOLVE I/II and ISAR TEST 4 studies showed the former to be associated with reduced clinically indicated TLR, without any change in ST.\(^{[22]}\)

Nevertheless, it should not be ignored that a short duration (<6 months) of dual antiplatelet therapy might be sufficient with EES as shown in the recently published meta-analysis,\(^{[23]}\) whereby this short treatment duration was considered reasonable, with a low percentage of major bleeding, similar death rate as well as similar ST.

This current meta-analysis showed results which were completely different from previously published network meta-analyses comparing BP-DES with DP-DES including DP-EES. These network meta-analyses showed DP-EES to be associated with better adverse outcomes compared to BP-DES.\(^{[1–3]}\) However,
Results from this current analysis involved data directly obtained from randomized trials and reported a very low risk of bias among several subgroups analyzing the adverse cardiovascular outcomes. Results of this analysis which were different from those network meta-analyses might have been because of the fact that network meta-analyses which are often referred to as mixed treatment comparison meta-analysis (MTC meta-analysis) are considered as extensions that allow direct and indirect comparisons in combinations, which, according to the recommendations from the Cochrane Collaboration, are not considered as randomized, but are considered as “observational findings across trials,” and may therefore suffer the biases reported among observational studies, for example owing to confounding, even if they included high-quality randomized trials.\textsuperscript{[5]}

Figure 5. Comparing the adverse cardiovascular events between biodegradable polymer drug-eluting stents (BP-SES) and durable polymer everolimus-eluting stents (DP-EES).
5. Limitations

Similar to other studies, this analysis also has limitations. First of all, owing to the limited number of patients, this analysis may not provide excellent results. Second, study Sepahram which reported cardiac mortality has been assumed to be all-cause mortality and included in the analysis. This might have a mild effect on the results of this current analysis. Moreover, the BP-DES group involved patients treated with different kinds of stents combined together (BP-SES, BP-EES, BP-BES). This could also be a limitation in this analysis which was partly solved when BP-SES and BP-BES were separately compared with DP-EES. Only 2 trials reported stroke. Using only 2 trials to analyze this specific subgroup might also be a limitation in this meta-analysis. Another limitation could be the different follow up periods reported and the duration of anti-platelets which was different in several trials. However, in most of the trials, the follow-up period was comparable.

Table 5

| Outcomes analyzed | No of trials involved (n) | OR with 95% CI | P | f (%) |
|-------------------|---------------------------|----------------|---|------|
| Mortality         | 10                        | 1.08 (0.87–1.34) | .47 | 0    |
| MI                | 9                         | 1.04 (0.84–1.28) | .72 | 0    |
| TVR               | 9                         | 1.11 (0.92–1.33) | .28 | 0    |
| TLR               | 9                         | 1.11 (0.94–1.33) | .22 | 0    |
| MACes             | 9                         | 1.12 (0.99–1.27) | .07 | 0    |
| Stroke            | 2                         | 1.13 (0.69–1.94) | .62 | 6    |
| Total ST          | 9                         | 0.85 (0.59–1.21) | .37 | 0    |
| Definite ST       | 7                         | 1.09 (0.92–3.08) | .09 | 0    |
| Probable ST       | 7                         | 0.67 (0.38–1.17) | .16 | 39   |

CI=confidence interval, MACes= major adverse cardiac events, MI=myocardial infarction, OR=odds ratio, ST=stent thrombosis, TL=total lesion revascularization, TLR=target vessel revascularization.

5. Limitations

Figure 6. Comparing the adverse cardiovascular events between biodegradable polymer drug-eluting stents (BP-BES) and durable polymer everolimus-eluting stents (DP-EES).
as well as the duration of anti-platelet treatment was restricted to 1 year.

6. Conclusion
Between 6 months and 3 years, BP-DES were similar in terms of cardiovascular outcomes compared to DP-EES. However, further long-term follow-up research is recommended. To be more precise, mortality, MACEs, stroke, and repeated revascularization were not significantly different between biodegradable DES and nonbiodegradable EES. Total ST was also not significantly different between these 2 types of stents. However, even if definite ST insignificantly favored DP-EES, further studies with longer follow-up periods should be recommended to completely solve this issue.

Acknowledgments
This research was supported by Youth Science Foundation of Guangxi Medical University (No. GXMUYSF201308), Scientific Project of Guangxi Higher Education (No. KY2015ZD028), and National Natural Science Foundation of China (No. 81560046).

References
[1] Kang SH, Park KW, Kang DY, et al. Biodegradable-polymer drug-eluting stents vs. bare metal stents vs. durable-polymer drug-eluting stents: a systematic review and Bayesian approach network meta-analysis. Eur Heart J 2014;35:1147–58.
[2] Navarese EP, Tandjung K, Claessen B, et al. Safety and efficacy outcomes of first and second generation durable polymer drug eluting stents and biodegradable polymer sirolimus eluting stents in clinical practice: comprehensive network meta-analysis. BMJ 2013;347:f6530.
[3] Bangalore S, Toklu B, Amoroso N, et al. Bare metal stents, durable polymer drug eluting stents, and biodegradable polymer drug eluting stents for coronary artery disease: mixed treatment comparison meta-analysis. BMJ 2013;347:f6625.
[4] Curtlip DE, Windecker S, Mehran R, et al. Academic Research Consortium Clinical end points in coronary stent trials: a case for standardized definitions. Circulation 2007;115:2344–51.
[5] Higgins JPT, Altman DG. Assessing risk of bias in included studies. In: Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions. Wiley; 2008; 187–241.
[6] Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health-care interventions: explanation and elaboration. BMJ 2009;339:b2700.
[7] Windecker S, Haude M, Neumann FJ, et al. Comparison of a novel biodegradable polymer sirolimus-eluting stent with a durable polymer everolimus-eluting stent: results of the randomized BIOFLOW-II trial. Circ Cardiovasc Interv 2015;8:e001441.
[8] Pilgrim T, Heg D, Roffi M, et al. Ultrathin strut biodegradable polymer sirolimus-eluting stent versus durable polymer everolimus-eluting stent for percutaneous coronary revascularisation (BIOSCIENCE): a randomised, single-blind, non-inferiority trial. Lancet 2014;384:2111–22.
[9] Jimenez VA, Iniguez A, Baz JA, et al. A randomized comparison of novel bioresorbable polymer sirolimus-eluting stent and durable polymer everolimus-eluting stent in patients with acute coronary syndromes: The CENTURY II high risk ACS substudy. Cardiovasc Revasc Med 2016;17:353–61.
[10] Smits PC, Hofma S, Togni M, et al. Abdominal biodegradable polymer sirolimus-eluting stent versus durable polymer everolimus-eluting stent.
[11] Byrne RA, Kastrati A, Massberg S, et al. Biodegradable polymer versus permanent polymer drug-eluting stents and everolimus- versus sirolimus-eluting stents in patients with coronary artery disease: 3-year outcomes from a randomized clinical trial. J Am Coll Cardiol 2011;58:1325–31.

[12] Meredith IT, Verheye S, Dubois CL, et al. Primary endpoint results of the EVOLVE trial: a randomized evaluation of a novel bioabsorbable polymer-coated, everolimus-eluting coronary stent. J Am Coll Cardiol 2012;59:1362–70.

[13] Natsuki M, Kozuma K, Morimoto T, et al. NEXT Investigators. Biodegradable polymer biolimus-eluting stent versus durable polymer everolimus-eluting stent: a randomized, controlled, noninferiority trial. J Am Coll Cardiol 2013;62:181–90.

[14] Gao RL, Xu B, Lansky AJ, et al. TARGET I Investigators. A randomised comparison of a novel abluminal groove-filled biodegradable polymer sirolimus-eluting stent with a durable polymer everolimus-eluting stent: clinical and angiographic follow-up of the TARGET I trial. Euro-Intervention 2013;9:75–83.

[15] Separham A, Sohrabi B, Aslanabadi N, et al. The twelve-month outcome of biolimus eluting stent with biodegradable polymer compared with an everolimus eluting stent with durable polymer. J Cardiovasc Thorac Res 2011;3:313–6.

[16] Kereiakes DJ, Meredith IT, Windecker S. Efficacy and safety of a novel bioabsorbable polymer-coated, everolimus-eluting coronary stent: the EVOLVE II Randomized Trial. Circ Cardiovasc Inter 2015;8:pi: e002372.

[17] Sun LX, Zhang J. Biodegradable polymer DES versus durable polymer everolimus-eluting stents for patients undergoing PCI: a meta-analysis. Heart Lung Circ 2014;23:496–502.

[18] Lee HJ, Park TK, Song YB, et al. Biodegradable polymer biolimus-eluting stent versus durable polymer everolimus-eluting stent in patients with acute myocardial infarction. Int J Cardiol 2015;183:190–7.

[19] Ye Y, Xie H, Zeng Y, et al. Efficacy and safety of biodegradable polymer biolimus-eluting stents versus durable polymer drug-eluting stents: a meta-analysis. PLoS One 2013;8:e78667.

[20] Pandya B, Gaddam S, Razzam M, et al. Biodegradable polymer stents vs second generation drug eluting stents: a meta-analysis and systematic review of randomized controlled trials. World J Cardiol 2016;8:240–6.

[21] Hur SH, Kim JC, Won KB, et al. KAMIR (Korea Acute Myocardial Infarction Registry) Investigators. Two-year safety and efficacy of biodegradable polymer drug-eluting stent versus second-generation durable polymer drug-eluting stent in patients with acute myocardial infarction: data from the Korea Acute Myocardial Infarction Registry (KAMIR). Clin Cardiol 2016;39:276–84.

[22] Lansky AJ, Kastrati A, Edelman ER, et al. Comparison of the absorbable polymer sirolimus-eluting stent (MiStent) to the durable polymer everolimus-eluting stent (Xience) (from the DESSOLVE I/II and ISAR-TEST-4 Studies). Am J Cardiol 2016;117:532–8.

[23] D’Ascenzo F, Moretti C, Bianco M, et al. Meta-analysis of the duration of dual antiplatelet therapy in patients treated with second-generation drug-eluting stents. Am J Cardiol 2016;117:1714–23.