12-\textit{vs.} >12-Month dual Antiplatelet therapy after Drug-eluting stent implantation: A meta-analysis

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Abstract

\textbf{Background:} The risks and benefits of different duration of dual antiplatelet therapy (DAPT) after drug-eluting stent (DES) implantation remains a matter of debate.

\textbf{Objectives:} To systematically review the risks and benefits of 12-month \textit{vs.} >12-month dual antiplatelet therapy (DAPT) after drug-eluting stent (DES) implantation.

\textbf{Methods:} Randomized controlled trials about duration of DAPT after DES implantation was searched through the PubMed, Cochrane Library, EMBase and Web of Science. No limitations regarding the language of publications.

\textbf{Results:} Six randomized controlled studies involving 25054 patients were included. The results of meta-analysis showed: 12-month DAPT was associated with a lower risk of all-cause mortality (FEM; RR=0.76; 95\%CI, 0.63 to 0.92; Z=2.78; P=0.006) and a higher risk of stent thrombosis (FEM; RR=2.48; 95\%CI, 1.72 to 3.56; Z=4.88; P=0.00001), myocardial infarction (FEM; RR=1.71; 95\%CI, 1.44 to 2.04; Z=6.02; P=0.00001). The rates of stroke, TVR, major bleeding and cardiac mortality had no significant difference between 12-month DAPT and >12-month DAPT.

\textbf{Conclusion:} 12-month dual antiplatelet therapy after drug-eluting stent implantation was associated with a lower risk of all-cause mortality and a higher risk of myocardial infarction and stent thrombosis. The rates of stroke, TVR, major bleeding and cardiac mortality had no significant difference between 12-month DAPT and >12-month DAPT.

Data Extraction

Two investigator independently reviewed the full text of the retrieved articles and reported the results in a structured dataset. Disparities between investigators regarding the inclusion of each trial were resolved by consensus by a third independent investigator. The data’s included first author, year, country of publication, study design, S-DAPT and L-DAPT duration, maximum length of follow-up, sample size, outcome measures and endpoints of interest. The assessment of the methodological quality of the included RCTs was followed the recommendations exemplified in the Cochrane handbook for systematic reviews of interventions and summarized in a domain based evaluation of the following components: random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting and other bias [3].

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Statistical Analysis

We used Review Manager 5.3 to conduct the statistical analysis. The between-study heterogeneity was assessed by the chi-squared test and its extent was quantified by the $I^2$ statistic ($I^2$ values of 25%, 50%, and 75% were considered to represent low, moderate and severe statistical inconsistency [4]. Continuous outcomes were analyzed using mean differences (MD) and 95% confidence intervals (CIs). Risk ratio (RR) and 95% CI were calculated by implementing the Mantel-Haenszel fixed effect model (FE) and the Mantel-Haenszel random effect model (RE). A $p<0.05$ was thought to indicate statistical significance in this meta-analysis.

Results

The study analysis flow diagram is shown in Figure 1. Of the 1039 citations found in MEDLINE, the Cochrane Library, EMBase and Web of Science, 6 trials met the inclusion criteria and the majority was excluded for reasons presented in Figure 1. Thus, six RCTs were included in the final meta-analysis [5-10].

In Table 1, we list the main characteristics of the included studies that meet our eligibility criteria. All studies [5-10] were published from 2010 to 2016. Their individual sample size ranged from 1259 to 9961 patients. All of the six trials were multi-center studies. Two RCTs evaluated a 12-month versus 30-month DAPT regimen. One RCT evaluated a 12-month versus a 24-month DAPT regimen. One RCT evaluated a 12-month versus a 36-month DAPT regimen. One RCT evaluated a 12-month versus a 48-month DAPT regimen. One RCT evaluated a 12-month versus an 18-30-month DAPT regimen. Data regarding the S-DAPT vs. L-DAPT are presented in Table 2. Data on the quality of the included studies are presented in Table 3.

All-cause mortality

Six RCTs (5-10) in this meta-analysis provided data on the all-cause mortality. No significant heterogeneity was detected between these studies (Chi$^2=8.44$, df=5; $P=0.13$; $I^2=41\%$). The combined estimate for the all-cause mortality based on the fixed-effects model showed statistically significant difference between the S-DAPT group and the L-DAPT group ($24595$ patients; FEM; RR=0.76; 95%CI, 0.63 to 0.92; $Z=2.78$; $P=0.006$) (Figure 2).

Cardiac Mortality

Four RCTs [5,7-9] in this meta-analysis provided data on the cardiac mortality. No significant heterogeneity was detected between these studies (Chi$^2=2.93$, df=3; $P=0.40$; $I^2=0\%$). The combined estimate for the cardiac mortality based on the fixed-effects model showed no statistically significant difference between the S-DAPT group and the L-DAPT group ($20604$ patients; FEM; RR=0.93; 95%CI, 0.71 to 1.23; $Z=0.50$; $P=0.61$) (Figure 3).

Figure 1. Flow diagram of the literature search and selection process of the studies.
Myocardial Infarction

Six RCTs [5-10] in this meta-analysis provided data on the rates of myocardial infarction. No significant heterogeneity was detected between these studies (Chi²=7.23, df=5; P=0.20; I²=31%). The combined estimate for the rates of myocardial infarction based on the fixed-effects model showed statistically significant difference between the S-DAPT group and the L-DAPT group (24282 patients; FEM; RR=1.04; 95%CI, 0.78 to 1.39; Z=0.29; P=0.77) (Figure 5).

Stroke

Six RCTs [5-10] in this meta-analysis provided data on the rates of stroke. No significant heterogeneity was detected between these studies (Chi²=3.11, df=5; P=0.68; I²=0%). The combined estimate for the rates of stroke based on the fixed-effects model showed no statistically significant difference between the S-DAPT group and the L-DAPT group (24467 patients; FEM; RR=1.06; 95%CI, 0.78 to 1.42; Z=0.77; P=0.44) (Figure 4).
Figure 2. The all-cause mortality. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.

Figure 3. The cardiac mortality. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.

Figure 4. The rates of myocardial infarction. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.

Figure 5. The rates of stroke. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.
L-DAPT group (24,125 patients; FEM; RR = 2.48; 95% CI, 1.72 to 3.56; Z = 4.88; P < 0.0001) (Figure 6).

TVR

Four RCTs [5-6, 8, 10] in this meta-analysis provided data on the rates of TVR. No significant heterogeneity was detected between these studies (Chi² = 1.41, df = 3, P = 0.70; I² = 0%). The combined estimate for the rates of TVR based on the fixed-effects model showed no statistically significant difference between the S-DAPT group and the L-DAPT group (9,956 patients; FEM; RR = 0.85; 95% CI, 0.68 to 1.06; Z = 1.45; P = 0.15) (Figure 7).

Major Bleeding

Four RCTs [5-6, 8, 10] in this meta-analysis provided data on the rates of major bleeding. No significant heterogeneity was detected between these studies (Chi² = 3.07, df = 3, P = 0.38; I² = 2%). The combined estimate for the rates of major bleeding based on the fixed-effects model showed no statistically significant difference between the S-DAPT group and the L-DAPT group (9,956 patients; FEM; RR = 0.68; 95% CI, 0.43 to 1.07; Z = 1.67; P = 0.09) (Figure 8).

Publication bias

Six studies [5-10] were included in this meta-analysis. Assessment of publication bias using a funnel plot was presented in Figure 9.

Discussion

This meta-analysis included six randomized controlled studies involving 25,054 patients. The main results of this meta-analysis are as follow:

1) 12-month DAPT was associated with a lower risk of all-cause mortality.
2) 12-month DAPT was associated with a higher risk of myocardial infarction and stent thrombosis.

![Figure 6](image6.png)  
**Figure 6.** The rates of stent thrombosis. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.

![Figure 7](image7.png)  
**Figure 7.** The rates of TVR. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.

![Figure 8](image8.png)  
**Figure 8.** The rates of major bleeding. Forest plot showing the comparison of S-DAPT vs. L-DAPT. The size of each square represents the proportion of information provided by each study. The vertical line depicts the point of “no difference” between the two groups, and the horizontal lines correspond to the 95% confidence intervals (CIs). Diamonds represent the risk ratio (RR) for all studies.
The rates of stroke, TVR, major bleeding and the cardiac mortality had no significant difference between the 12-month DAPT and >12-month DAPT.

Optimal DAPT duration is critical for balancing the risk of ischemic and bleeding complications after DES implantation. Elmariah, et al. [11] confirmed that patients’ mortality was no significant difference between short term of DAPT and long term of DAPT after DES implantation. Giustino, et al. [12] confirmed that all-cause mortality was numerically higher with long term of DAPT without reaching statistical significance. However, in this meta-analysis, we found that the short term of DAPT was associated with a lower risk of all-cause mortality (FEM; RR=0.97; 95%CI, 0.63 to 0.92; Z=2.78; P=0.006). While the cardiac mortality between the short DAPT and long DAPT had no significant difference (FEM; RR=0.93; 95%CI, 0.71 to 1.23; Z=0.50; P=0.61).

Recently, trials demonstrated that Prolonged DAPT reduced stent-related and non-stent-related adverse ischemic events following PCI [13]. American guidelines recommend at least 12 months of DAPT after DES implantation in order to reduce the rates of late and very late stent thrombosis. In this meta-analysis, results showed that short term of DAPT (12 months) was associated with a higher risk of stent thrombosis (FEM; RR=2.48; 95%CI, 1.72 to 3.56; Z=4.88; P<0.00001), as well as myocardial infarction (FEM; RR=1.71; 95%CI, 1.44 to 2.04; Z=6.02; P<0.00001).

The definition of major bleeding complications varies widely across clinical studies. In this meta-analysis, we adopted the TIMI major bleeding scale. The results showed that the major bleeding between 12-month DAPT and >12-month DAPT after drug-eluting stent implantation had no significant difference (FEM; RR=0.68; 95%CI, 0.43 to 1.07; Z=1.67; P=0.09).

The results of this meta-analysis confirm and extend the previous reports [14-21]. However, this meta-analysis has several limitations. First, not all included studies provided data on all outcomes. Second, four trials included in the meta-analysis were open label, potentially introducing performance bias. Third, all of the patients included in the meat-analysis were treated with clopidogrel as adjunctive therapy to aspirin. It remains unclear whether results would have differed with the other kind of P2Y12 inhibitor, especially in patients with acute coronary syndrome.

Conclusion

In conclusion, 12-month dual antiplatelet therapy after drug-eluting stent implantation was associated with a lower risk of all-cause mortality and a higher risk of myocardial infarction and stent thrombosis. The rates of stroke, TVR, major bleeding and cardiac mortality had no significant difference between 12-month DAPT and >12-month DAPT. Further research is required to determine the duration of DAPT after DES implantation in patients with ACS.

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