JPPIPA 9(9) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Outcomes of Optical Coherence Tomography Compared with Intravascular Ultrasound to Guide Percutaneous Coronary Intervention: A Systematic Review and Meta-Analysis of Randomized Control Trials

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Received: June 23, 2023
Revised: August 29, 2023
Accepted: September 25, 2023
Published: September 30, 2023

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DOI: 10.29303/jppipa.v9i9.4870

Abstract: In the recent years, the alternative intravascular imaging modalities that are most frequently employed to direct and optimize PCI have been intravascular ultrasound (IVUS) and optical coherence tomography (OCT). The comparative effectiveness of OCT-guided vs IVUS-guided PCI is still up for debate. The purpose of this study was to conduct a systematic review and meta-analysis of all available studies comparing OCT-guided versus intravascular ultrasound (IVUS)-guided PCI. Electronic journals searching were performed in PubMed, ScienceDirect, and Cochrane from January 2015 to March 2023 to identify randomized control trial (RCT) studies that compare OCT‑guided PCI to IVUS‑guided PCI. Meta-analyses were performed on included studies and Odds ratio (OR) and 95% Confidence Interval (CI) were estimated using Review Manager v5.4. A total of four RCT enrolling 1316 participants were included in our analysis. There is no statistical significance was observed in the OCT versus IVUS comparison on all cause mortality [OR = 1.75, 95% CI (0.52, 5.88), p = 0.37], cardiovascular mortality [OR = 1.40, 95% CI (0.27, 7.11), p = 0.69], MACE [OR = 1.04, 95% CI (0.63, 1.71), p = 0.88], ST [OR = 0.94, 95% CI (0.16, 5.52), p = 0.95], TLR [OR = 0.77, 95% CI (0.39, 1.50), p = 0.44], and TVR [OR = 1.19, 95% CI (0.68, 2.07), p = 0.54].

Keywords: Intravascular ultrasound; Optical coherence tomography; Percutaneous coronary intervention

Introduction

The mainstay for treating culprit lesions in individuals with coronary artery disease is angiography guided percutaneous coronary intervention (PCI). When compared to earlier generations of stents, drug-eluting stents (DES), which have a good effect on clinical outcomes, are now widely used. This is the result of impressive developments in stent technology. Significant advancements have also been made in invasive imaging techniques, including as intravascular ultrasound (IVUS) and optical coherence tomography (OCT), which can be used to direct PCI (Hibi et al., 2014).

Studies and meta-analyses have shown that IVUS-guided PCI is superior to angiography-guided PCI in terms of patient outcomes (Bavishi et al., 2017; Darmoch et al., 2020). The use of longer and bigger stents that are designed to reduce malapposition, treat significant edge dissection, maximally expand stents, and enhance minimum stent area (MSA) may improve post-PCI outcomes when IVUS guidance is used. Even though IVUS has a greater resolution than angiography, it is still challenging to scan minute structures, such as modest

How to Cite:
Pramana, K. A. A. P., Cahyani, N. G. A. M. S. D., & Pintaningrum, Y. (2023). Outcomes of Optical Coherence Tomography Compared with Intravascular Ultrasound to Guide Percutaneous Coronary Intervention: A Systematic Review and Meta-Analysis of Randomized Control Trials. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 698–703. https://doi.org/10.29303/jppipa.v9i9.4870

procedural problems, and IVUS-guided PCI is seldom used in most centers because of this (Mintz et al., 2001; Smilowitz et al., 2018).

An alternative intravascular imaging technique with better resolution than IVUS is optical coherence tomography (OCT), which is utilized for PCI guiding and optimization. With a resolution ten times that of IVUS and the ability to differentiate between plaque characteristics and more accurately detect post-PCI complications like malapposition and edge dissections that may not be easily detected on IVUS, optical coherence tomography is perhaps able to overcome the aforementioned limitations (Braaf et al., 2019; Oosterveer et al., 2020). However, the lack of clinical trials with sufficient power now restricts its usage in ordinary clinical practice. This study compares the clinical results of OCT and IVUS to direct PCI by doing a comprehensive review and meta-analysis of all relevant randomized control trial trials. This study is important to compare the outcomes of each intravascular guided percutaneous coronary intervention modality.

Method

This systematic review and meta-analysis were performed according to the preferred reporting items for systematic reviews and meta- analyses (PRISMA) and the Cochrane Collaboration guidelines (Figure 1). This systematic review and meta-analysis protocol's was entered with the ID CRD42023449689 into the International Prospective Register of Systematic Reviews (PROSPERO).

Data Sources, Search Strategy and Study Selection

Randomized control trial (RCT) studies comparing OCT-guided PCI to IVUS-guided PCI that reported at least one of the following outcomes—all-cause mortality, cardiovascular mortality, major adverse cardiovascular events (MACE), stent thrombosis (ST), target lesion revascularization (TLR), or target vascular revascularization (TVR)—were all included in the meta-analysis. Additionally, studies were only included if they employed metallic drug-eluting stents during PCI.

Data Extraction and Quality Assesment

In Microsoft Excel, all articles found through the systematic search were catalogued, and duplicates were found and eliminated. Only those trials that satisfied the previously established criteria were chosen after the other publications had a comprehensive evaluation by two independent reviewers (KAAPP and NGAMSDC). The titles and abstracts of all studies were initially used to make a short selection, and then the complete article was examined to ensure relevance. To settle any disagreements, a third investigator (YP) was consulted. To evaluate the caliber of included RCTs, the modified Cochrane Collaboration's risk of bias method was utilized. Four RCTs studies in all satisfied the inclusion criteria for the analysis, enrolling 1316 people, with a mean age of 66.4 years and a median follow-up of 17 months, as indicated in the Preferred Reporting Items for Reviews and Meta-analyses flowchart in Figure 1.

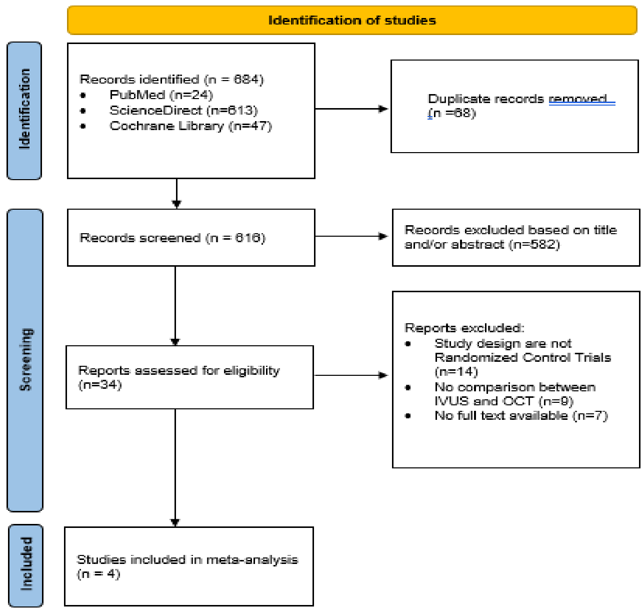

Figure 1. The PRISMA flowchart

Statistical Analysis

All statistical evaluations were performed using Review Manager 5.4.1. A fixed-effects model was used to pool the dichotomous outcomes and display them as odds ratios (ORs) with matching 95% confidence intervals (CIs). Using Higgins I2 statistics, heterogeneity between trials was assessed; I =25%–50% was deemed mild, 50%–75% was deemed moderate, and >75% was deemed severe heterogeneity. To assess the publication bias, Begg's test and a visual inspection of the funnel plot were used. P<0.05 was regarded as significant.

Result and Discussion

Study Included in The Analysis

Table 1 provides a summary of the characteristics of the included studies and individuals. Based on the modified Cochrane Collaboration's risk of bias assessment (Figure 2), the risk of bias of included studies is generally low. We observed a symmetrical funnel plot that showed little publishing bias.

Table 1. Summary of Included Studies

Variable	(Ali et al., 2021)	(Chamié et al., 2021)	(Kubo et al., 2017)	(Muramatsu et al., 2020)
Year	2021	2021	2017	2020
Study design	RCT	RCT	RCT	RCT
Sample (n) OCT/IVUS	153/136	51/50	412/405	54/55
Age (years)	66/66	59.92/59.32	69/68	72/71
Male (n)	109/107	31/36	315/322	41/44
Follow up duration (months)	12	12	8	36

Figure 2. Quality assessment of included studies based modified Cochrane Collaboration's risk of bias tool

All Cause Mortality

In two of the four included RCT studies, all-cause mortality was recorded. The comparison of all-cause mortality between OCT-guided and IVUS-guided PCI did not reveal any statistically significant differences [OR = 1.75, 95% CI (0.52, 5.88), p = 0.37] (Figure 3).

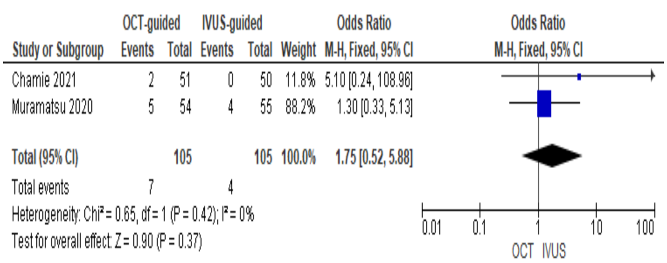

Figure 3. Forest Plot of All-Cause Mortality

Cardiovascular Mortality

Cardiovascular mortality was recorded in three of the four RCT trials that were included. The comparison of OCT-guided versus IVUS-guided PCI on cardiovascular mortality did not reveal any statistically significant differences [OR = 1.40, 95% CI (0.27, 7.11), p = 0.69] (Figure 4).

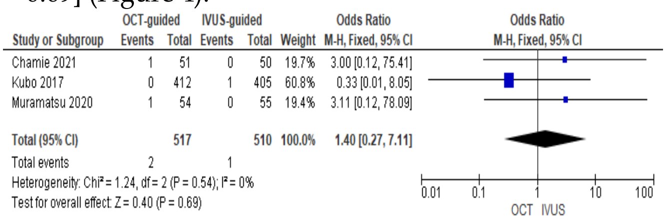

Figure 4. Forest Plot of Cardiovascular Mortality

Major Adverse Cardiovascular Events (MACE)

MACE was reported in four included RCT trials. On MACE, there was no statistically significant difference between OCT and IVUS [OR = 1.04, 95% CI (0.63, 1.71), p = 0.88] (Figure 5).

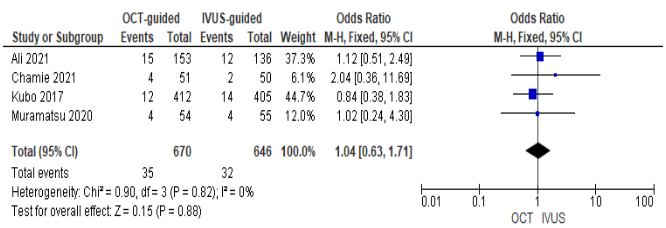

Figure 5. Forest Plot of MACE

Stent Thrombosis (ST)

ST was recorded in two of the four included RCT investigations. On ST, there was no statistically significant difference between OCT and IVUS [OR = 0.94, 95% CI (0.16, 5.52), p = 0.95] (Figure 6).

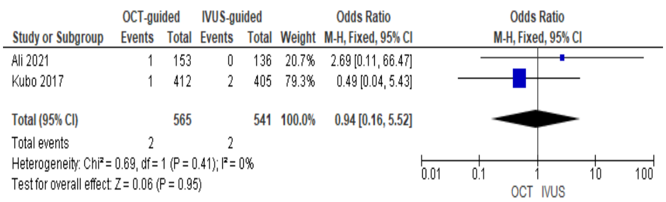

Figure 6. Forest Plot of ST

Target Lesion Revascularization (TLR)

TLR was reported in four included RCT trials. OCT versus IVUS comparison on TLR showed no statistically significant differences [OR = 0.77, 95% CI (0.39, 1.50), p = 0.44] (Figure 7).

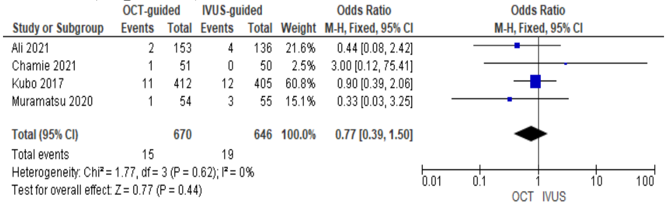

Figure 7. Forest Plot of TLR

Target Vascular Revascularization (TVR)

TVR was reported in three of the four included RCT trials. On TVR, there was no statistically significant difference between OCT and IVUS [OR = 1.19, 95% CI (0.68, 2.07), p = 0.54] (Figure 8).

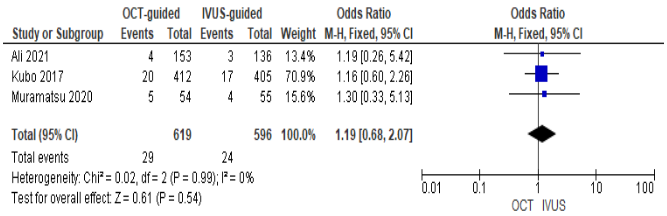

Figure 8. Forest Plot of TVR

We conducted a thorough evaluation and meta-analysis of 1316 patients to compare the results of OCT-guided PCI with IVUS-guidance. The comparison of OCT- versus IVUS-guidance revealed no statistically significant difference in any of the clinical outcomes (mortality from all causes, cardiovascular mortality, major adverse cardiovascular events, stent thrombosis, target lesion revascularization, and target vascular revascularization, or TVR) from this meta-analysis. Complete vascular wall imaging provided by IVUS enables correct evaluation of the plaque burden, degree of stenosis, and calcification as well as ensuring proper stent expansion and apposition. OCT, an optical version of IVUS with 10 times more resolution, can also provide accurate evaluation of identical parameters. Further research is required to determine whether OCT's greater resolution can guide PCI with a more favorable clinical result than IVUS (Fujii et al., 2005; Kubo et al., 2013).

Similar to the results of our meta-analysis, Kim et al.'s propensity matched investigation on clinical outcomes at 1 year revealed no statistically significant difference in the outcome rates between OCT-guided and IVUS-guided PCI groups (Kim et al., 2016). A meta-analysis by Kuku, et al in 2018 that compare OCT-guided percutaneous coronary intervention with other imaging guidance also showed no statistically significant difference in all clinical outcomes (MACE, cardiac deaths, MI, ST, and TLR) between OCT-guided versus IVUS-guided PCI (Kuku et al., 2018). Recent systematic review and meta-analysis in 2022 by Siddiqi, et al that compare OCT-guided percutaneous coronary intervention with angiography and IVUS guidance also showed no statistically significant difference in all clinical outcomes (MSA, all cause mortality, cardiovascular mortality, MACE, MI, ST, TVR and TLR) between OCT-guided versus IVUS-guided PCI (Siddiqi et al., 2022).

Because the two modalities operate essentially identically, an inconsequential result for each of these outcomes is anticipated. In order to accurately assess the impact of OCT guidance against other imaging modalities, more appropriately powered RCTs are needed, which is why this metaanalysis should be viewed as hypothesis generating. Given a number of limitations, the current meta-analysis should be interpreted accordingly. First, it was assumed that the baseline characteristics of the patients in the included studies would be comparable when performing this meta-analysis. Although differences in patient characteristics and prior treatments may have played a role in the development of clinical heterogeneity. Second, the meta-analysis's inclusion of only four RCT trials was constrained by their small sample sizes. We anticipate RCT studies with a sizable sample size that compare the results of OCT guided vs IVUS guided PCI in the future.

Conclusion

In conclusion, this systematic review and meta-analysis revealed that there was no statistically significant difference in clinical outcomes observed in the comparison between OCT guidance and IVUS guidance. There is a need for more high powered randomized clinical trials comparing OCT-guidance with IVUS-guidance or other imaging guidance to adequately assess the role of cardiac OCT imaging in PCI.

Acknowledgements

The author thanks all who contributed to the writing of this article.

Author Contributions

The data were accessible to all authors, who also gave the work a thorough review before submission. Before submission, this article was reviewed and approved by all authors. Conception and design contributed by KAAPP; Analysis and interpretation contributed by KAAPP, NGAMSDC, YP; Data collection contributed by KAAPP, NGAMSDC, YP; Writing the article contributed by KAAPP, NGAMSDC, YP; Critical revision of the article contributed by YP; Final approval of the article contributed by KAAPP, NGAMSDC, YP; Statistical analysis contributed by KAAPP, NGAMSDC, YP; Overall responsibility contributed by KAAPP.

Funding
Not applicable

Conflicts of interest
There is no conflict of interest

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