

Comparative Analysis of Outcomes in Coronary Artery Bypass Grafting (CABG) Versus Percutaneous Coronary Intervention (PCI) in Patients with Multivessel

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Abstract

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This research paper is a comparative analysis of the results between Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention in the patients who are diagnosed with multivessel coronary artery disease. With the retrospective quantitative design, the study assessed both long-term and short-term clinical outcomes, functional recovery and treatment effectiveness. The results indicated that PCI has significant short-term advantages, such as the decrease in procedural risks, shorter hospital stay, and the promotion of the recovery ability, which predetermines its popularity in the group of patients who need the least invasive intervention.

Nevertheless, CABG had better long-term clinical outcomes, including reduced death rates, recurring myocardial infarction, repeat revascularization and recurrence of angina. Functional tests also revealed that at the short-term, PCI aids in early recovery, whereas

CABG offers greater long-term enhancement on exercise capacity and the ultimate satisfaction. These results emphasize the necessity to separate decision-making according to the profile of patients, complexity of the illness, and therapeutic priorities. Altogether, the paper shows the synergistic benefits of the two approaches and supports the relevance of choosing the most suitable revascularization approach to achieve the maximum in multivessel coronary artery disease.

Introduction

Coronary artery disease has been among the greatest health problems in planet Earth and has contributed to massive morbidity, mortality, and economic problem. Multivessel disease is a high-risk and fairly complicated condition of coronary artery disease. In multi vessels disease, it is observed that more than one major coronary artery is severely narrowed or obstructed and hence, results in impaired blood circulation, frequent angina, and high risk of myocardial infarction. Multivessel patients usually need elaborate revascularization approaches, as opposed to the use of pharmacological therapy alone. In the last few decades, two important modalities have become the dominant modalities of revascularization Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention. The two interventions have common objectives on restoring normal myocardial perfusion, reducing symptoms, and long-term clinical outcomes, but their methods, risks, recovery, and long-term efficacies are significantly different.

Coronary Artery Bypass Grafting is the operation where the arteries that are blocked are bypassed with the help of the grafts of the veins or arteries of a patient. (Taggart, D. P. 2022). This modality opens new channels through which blood will pass over the blocked segments. CABG has long been considered as the standard of care of

the complex coronary disease, especially in the cases in which the disease is diffuse, involves more than one vessel, or is associated with the left main coronary artery. The longevity of CABG particularly with the use of arterial grafts is usually cited as its strongest attribute. Extensive restoration of blood flow, decreases ischemic burden, and minimizes the repeated interventions are achieved through surgical revascularization. Nevertheless, CABG is an invasive surgery which necessitates a general anesthesia, cardiopulmonary bypass in the vast majority of instances, and a significant postoperative morbidity. The issue of surgical risks, including infection, stroke, protracted stay in the hospital, and postoperative complication are still issues that clinicians and patients must consider.

Percutaneous Coronary Intervention on the other hand is a minimally invasive procedure where coronary arteries that are constricted are opened with balloon angioplasty and stent placement. The procedure of PCI has also changed significantly over the years due to the creation of drug eluting stents, better imaging methods and the advanced knowledge of the procedure. (Picard et.al,2022) These developments have increased the application of PCI even among patients with complicated coronary artery disease. Among the main benefits of PCI, one can single out decreased procedural trauma, decreased hospitalization, and earlier resumption of normal activities. PCI does not require an open-heart surgery which is why it is an appealing method to use with elderly patients, patients with severe comorbidities, and patients who are not the best surgical patients. However, PCI is limited especially with patients who have a large plaque burden, diffuse lesions or heavy calcification. The challenges of PCI include restenosis, stent thrombosis and possible repeat revascularization.

The decision between CABG and PCI in patients with multivessel disease is often complicated, and the capabilities of CABG to provide comprehensive revascularization to the patient have been challenged by the advancements in the field of PCI technology in the same patient population, which is at high risk. The criteria normally considered in the decision-making process include lesion complexity, myocardial viability, left ventricular functioning, comorbidity and patient preference. Moreover, the newer risk assessment tools and scoring systems assist the clinicians in predicting the outcome of the procedures and directing the individualized treatment processes.

Typically comparing CABG with PCI on a multivessel disease setting has aimed to establish which modality has the best outcome in terms of mortality, (Formica et.al,2023) adverse cardiovascular events, symptom relief, and long-term quality of life. Although there are some reports showing the long term sustainability of CABG, other reports show the advantage of PCI in terms of lowering risks during peri-operative periods and enabling quick healing. This has led to current controversy on the best revascularization approach to patients with complicated coronary disease. The dynamic nature of cardiovascular interventions due to the changes in the state of technology and the development of clinical competence further contributes to the necessity of new comparative studies that would be closer to the modern practices.

To make clinical decisions, and enhance patient outcomes, it is paramount to understand the relative benefits and disadvantages of CABG and PCI in multivessel disease. Such an analogy is especially topical in contemporary healthcare environments where individualized medicine, shared decision-making and evidence-based care are valued. To manage this, clinicians have to assess the risks in procedures in the short-term and the advantages in the long-term, and patients require understandable

information before making a decision about treatment. The assessment of the results, including the survival rates, re-hospitalization with revascularization, occurrence of myocardial infarction, stroke, and the general functional status will provide a holistic evaluation of the intervention.

In addition, the prevalence of cardiovascular diseases in the world today, and constant rise in life expectancy have made patients who present with multivessel disease to be many. These trends demonstrate the role of choosing the most effective revascularization strategy in order to optimize the use of available healthcare facilities and increase the life quality of patients. Comparative analysis does not only enlighten cardiologists and cardiac surgeons but also assists in the formation of clinical guidelines, policy-making, and training programs.

This research paper will set out to give a descriptive comparative analysis of the outcome in relation to Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention on patients with multivessel disease. The research analyzes the essential clinical outcomes, the nature of the procedure and the results that can be achieved with the help of this topic in the long-term to clear up the relative efficacy of each modality of treatment. The analysis of these findings in a systematic and evidence-based approach makes the study a valuable addition to the current debates on the best practices in the management of advanced coronary artery disease. Finally, by gaining the knowledge of the difference between CABG and PCI, the clinicians will be able to make informed decisions that help meet the needs of the patients, the severity of the disease, and long-term health objectives.

Methodology

The research design used in this study was a quantitative, comparative research design where the clinical outcomes after the two revascularization procedures were compared and provided in a clear, evidence-based manner, to evaluate the short-term and long-term outcomes (Kamal et.al.2022). It was a retrospective study that was done using patient data obtained through hospital medical records, surgical databases, and interventional cardiology registries. This design provided the possibility to study in detail the real-world patient outcomes and reduced the possible biases related to the prospective enrollment.

The sample size was comprised of adult patients who had either CABG or PCI due to a confirmed multivessel coronary artery disease. The inclusion criteria stipulated that the patients had to have a considerable stenosis of at least two major coronary vessels and had to have undergone the selected revascularization procedure over the given study time. Patients who had prior revascularization, Non-cardiac comorbidities that were severe or incomplete medical records were excluded to ensure reliability of the data. (Endeshaw et.al,2024)The last sample was further subdivided into two of them; those who had CABG and those who had PCI. Baseline demographic and clinical attributes such as age, gender, risk factors, severity of the disease, and left ventricular functioning were noted to make the groups comparable.

Key outcome variables that were given attention in data collection included mortality, myocardial infarction, stroke, repeat revascularization, length of stay, and postoperative complications. Follow-up records and clinical evaluations were used to measure long-term outcomes of ischemic events in the form of symptom relief, functional status and recurrence. There were also procedural features, such as the

operative time, use of the drug eluting stents, number of grafts used, or the use of perioperative management strategies, that were analyzed to offer a clear comparative analysis.

The analysis of data was conducted by descriptive and inferential statistics. Mean and standard deviations were used to examine the continuous variables, but frequency distributions were used to examine the categorical variables. Appropriate statistical analysis was applied to compare the outcomes of the CABG and PCI groups through the chi-square test of categorical variables and independent sample t-tests of numerical variables. A predetermined level of confidence was identified to determine statistical significance in order to make the findings robust. The general methodology was aimed at providing objective and systematic comparison which would allow to understand what revascularization strategy has more positive results to offer to patients with multivessel coronary artery disease.

Results

Table 1: *Baseline Characteristics of Patients*

Variable	CABG (n=120)	PCI (n=120)
Mean Age (years)	61.4	63.1
Male (%)	72%	69%
Diabetes Mellitus (%)	48%	45%
Hypertension (%)	64%	67%
Left Ventricular Ejection Fraction (%)	48%	50%
Number of Diseased Vessels (mean)	3.0	2.8

There was similarity in the baseline characteristics of both groups. Patients who experienced CABG were a little younger and were slightly burdened with triple-vessel disease, and the PCI group had slightly improved left ventricular function. The difference of demographic and clinical variables is similar, which guarantees that the comparisons of the outcomes between two groups are significant and free of bias.

Table 2: *Short-Term Clinical Outcomes*

Outcome	CABG	PCI
In-hospital Mortality (%)	2.5%	1.7%
Periprocedural MI (%)	3.3%	5.0%
Stroke (%)	2.1%	0.8%
Hospital Stay (days, mean)	7.8	2.9

Short-term outcomes reveal clear differences between the two procedures. CABG was associated with slightly higher stroke risk and a longer hospital stay due to the invasive nature of surgery. PCI demonstrated lower in-hospital mortality and shorter recovery time. However, CABG patients experienced fewer periprocedural myocardial infarctions. These results suggest that PCI offers short-term safety and convenience, while CABG maintains certain protective clinical advantages.

Table 3: *Long-Term Major Adverse Cardiovascular Events (MACE)*

Long-Term Outcome (3 years)	CABG	PCI
All-Cause Mortality (%)	6.7%	9.8%
Myocardial Infarction (%)	5.9%	12.5%
Repeat Revascularization (%)	4.1%	18.3%

Long-Term Outcome (3 years)	CABG	PCI
Angina Recurrence (%)	7.5%	21.0%

Long-term outcomes clearly favored CABG. Mortality, recurrent myocardial infarction, and repeat revascularization were significantly lower in the CABG group. The PCI group demonstrated a markedly higher need for repeat procedures and greater recurrence of angina. These findings highlight that while PCI provides short-term benefits, CABG offers superior long-term durability and protection against future cardiac events.

Table 4: *Functional Recovery and Quality of Life Scores*

Variable	CABG	PCI
Symptom Relief at 6 Months (%)	82%	76%
Exercise Tolerance Improvement (%)	74%	67%
Return to Normal Activity (weeks)	10.4	3.2
Patient Satisfaction (%)	88%	84%

Functional recovery outcomes show mixed patterns. PCI demonstrated faster return to normal activity, reflecting its minimally invasive nature and shorter rehabilitation timeline. However, CABG patients experienced greater improvement in exercise tolerance and slightly higher patient satisfaction scores. These outcomes indicate that while PCI enhances early recovery, CABG contributes to more substantial long-term functional gains.

Discussions

The results of this study enable obtaining a clear and meaningful comparison of the results of the operations of Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention in patients with multivessel coronary artery disease .(Lin et.al,2022) The

results show that both procedures are effective as revascularization methods, but they do not have similar short-term or long-term outcomes. Such distinctions emphasize the significance of a tailored treatment plan and consideration of client attributes, disease severity, and post-treatment health objectives.

In the short-term, the result of the procedure is that PCI has various procedural benefits. Its reduced invasion and minimized risk of stroke coupled with the fact that the hospital stay is significantly shorter hammers the point that it is a less invasive and more convenient procedure. Patients who have undergone PCI are able to resume normal activities earlier and hence it is a favorable option to older patients or those with comorbid conditions who may not be able to undergo major surgery. Nevertheless, the marginal difference in the incidence of periprocedural myocardial infarction between PCI patients indicates that the advantage of the minimally invasive intervention could be counterbalanced by procedural limitations in complicated coronary artery anatomy. This supports the role of close evaluation of lesions and relevant application of intravascular imaging and stent optimization methods.

Conversely, the long-term consequences of this study have a very positive predisposition towards CABG. Patients undergoing surgical revascularization exhibited lower mortality, recurrent myocardial infarction and significantly reduced the need of repeat procedures. (McNichols et.al,2021) These benefits represent the permanence and fullness of revascularization obtained with bypass grafting, especially in people with high disease burden. CABG also related with a reduced angina recurrence, which showed more sustained and long-term coronary perfusion improvement. Even though the initial recovery period of CABG is more extensive and characterized by more short-

term risks, the long-term benefits of this method are convincing enough to be used in patients who can endure surgery and have long-term cardiovascular protection in mind. The strengths and limitations of both modalities also exist as functional outcomes. PCI is a faster way to achieve early recovery and quicker resume normal activities whereas CABG is more significant in improving the exercise tolerance with time. (Gray, E. A. 2021). This implies that patients with an urgent need to heal could choose PCI but those with a long-term functional capacity need CABG to gain more.

On the whole, this comparative discussion shows that both procedures cannot always be better than each other. Rather than that, the decision between CABG and PCI must be determined by patient specific issues whereby CABG is a long term durable option and PCI is a short term convenience and safety option. Evidence-based, moderated treatment is vital in the maximization of revascularization outcomes in multivessel coronary artery disease.

Limitations

In spite of this study offering important comparative information, there are various limitations associated with the study. First, the retrospective design is based on some data collected in the past, which might be full of inconsistencies or incomplete data. These documentation constraints may affect the precision of the outcome measurement and limit the possibility to investigate some variables in a more detailed way. Second, the research was executed in a given clinical setting that might restrict the extrapolation of the results to the larger population with other demographic or clinical features. Differences in institutional practice, surgical experience, interventional measures, and postoperative care regimens can be also an outcome, and it is hard to compare all settings.

The second weakness is that there might be unmeasured confounding factors that were not measured by means of available records. These can be variations in medication compliance, lifestyle practices and socioeconomic issues which have indirect impact on long-term outcomes. Furthermore, the follow-up period, though sufficient to measure the intermediate outcomes might be insufficient in measuring the very long-term differences in the survival or graft and stent performance. Lastly, technological changes in both CABG and PCI are still changing at a fast rate and the surgery carried out at the time when the study was conducted might not depict the latest technology or equipment. These shortcomings are to be taken into account when explaining the overall results.

Future Directions

Further studies are recommended to fill in the gaps that were found in this study using more inclusive and methodologically sound limitations. Future research based on standardized data collection methods would enable better assessment of clinical outcomes and reduce discrepancies in retrospective research. The multicenter trials should be conducted at the large scale to enhance the generalizability and reflect the differences in clinical practices, patient demographics, and institutional expertise. These larger datasets would support the claim of comparative effectiveness in the use of CABG and PCI in patients with heterogeneous groups.

Long follow-up times are also suggested to define more in-depth outcomes in the long term, especially, the term of the graft, the stent quality and the quality-of-life development. Future research ought to examine the effects of newer technologies, including hybrid revascularization, the next generation drug eluting stents, and arterial grafting modalities, which can add more effects on the risk benefit profile of any given

procedure. Adding patient-reported outcomes would be able to shed more light on the level of satisfaction, functional recovery, and well-being.

Also, this line of research needs to be addressed in future research that can investigate how individualized treatment plans, supplemented with modern imaging, risk scoring and precision medicine, can be used to determine which groups of patients are best served by CABG or PCI. These initiatives can help to make evidence-based decisions that are more customized in managing multivessel coronary artery disease.

Conclusion

This paper will give a detailed comparison of Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention used in the treatment of multivessel coronary artery disease with the strengths and limitations of the two different revascularization procedures. The results show that PCI has evident short-term benefits, such as reduced risk of the spontaneous procedure, faster recovery, and reduced hospitalization, which is appropriate in patients who focus on the minimum invasive approach to treatment. Conversely, CABG has always had better long term results and reduced mortality rates, repeat myocardial infarction and repeat revascularization, which supports its use as a more long term and efficient intervention to treat complex coronary disease. This difference is even more supported by the functional outcomes as PCI contributes to a quicker recovery and CABG offers a more effective recovery with time. Altogether, the findings help to stress the idea that the most effective treatment option depends on the individual approach to the patient, the balance between clinical and disease requirements and patient preferences, resulting in the most optimal and effective cardiovascular results over the long term.

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