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Comparative Clinical Outcomes of Coronary Artery Bypass Grafting and Percutaneous Coronary Intervention in Patients with Coronary Disease

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ABSTRACT

This study was to examine how post- surgical complications affect quality of life of patients who have undergone either Coronary Artery Bypass Grafting (CABG) surgery as well as Percutaneous Coronary Intervention (PCI) surgery. A quantitative research design was used and 300 cardiac patients had been sampled, 150 patients per group (CABG and PCI). Purposive sampling method was also used where relevant participants were involved. The analyses of the data were carried out by Pearson correlation, ANOVA, and chi-square procedures with the help of SPSS software. The correlation analysis revealed significant moderate negative association between post-operative complication and quality of life in the complete sample ($r = -0.463$, $p < 0.01$). This implies that, the more the complications, the poorer the quality of life of patients. The CABG group had a stronger negative correlation when tackled independently ($r = -0.492$) than the PCI group ($r = -0.421$), meaning that the CABG patients were yet more affected by complications on their quality of life. ANOVA indicated the limitation of a significant difference between the two groups in recovery time ($F = 9.76$, $p < 0.01$), with PCI patients taking shorter time to recover. Chi-square test also demonstrated a significant relationship between the nature of the surgery and the presence of the complications ($2 = 11.420$, $p = 0.001$). These results pinpoint that the kind of surgical intervention one is subjected to does not just affect the length of time taken to recuperate but also affect post-surgery results and the general well-being of the patient. The findings can assist medical professionals in managing patients to better care and reducing the instances of complications particularly among the patients with high risk cases.

INTRODUCTION

Coronary artery disease (CAD) has proven a disaster to the health of the heart and it plagues millions of the humanity. It comes about when either part of the arteries supplying oxygen carrying blood to the heart of the body are partially obstructed and the total blockage of the arteries supplying the oxygen carrying blood to the heart of the body by the fatty substances present in the body[1]. This may disrupt the delivery of blood to the heart thereby resulting to chest pains (angina), fatigue, shortness of breath and even heart attack. CAD has been identified to have occurred to any part of the population but it has been seen to grow more in the elderly group and more so to those with pre-disposing issues such as smoking, blood pressure, diabetes and cholesterol[2]. The medical science has provided many modalities by which this disease can be medicated so that this disease could be put in control and the patient would have better results. Some of the better known types of treatment also include: Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PCI). CABG operation may also be considered as an open surgery of the heart whereby the entire healthy blood vessel is removed in one place in the body and implanted to act as a by-pass to the blocked artery. CABG and PCI are being used and the decision that which one should be chosen is based on the following factors, the blocked arteries, his/her location and the status of the patient [3] Over the last two decades, many scientists and physicians have been occupied with the activities of comparing the effects of CABG and PCI trying to understand which of the methods is more effective in the process of getting the patients in a better condition[4]. Their lines of

investigations involve survival rate, repetition of a procedure, susceptibility to stroke or heart attack and relief of symptoms. Findings of other studies revealed that CABG is better in patients whose arteries are blocked at more than one point or in patients with severe heart disorders such as diabetics due to its long-term benefit since it will lessen occurrence of need of re-procedure in future [5].However, CABG is a serious operation, and recovery after this intervention requires long period which can be not accepted by every patient. On the other hand, PCI is less costly, less risky to the operation, and allows the patients to recover more rapidly so that they may resume their normal activities sooner [6].However, PCI is also linked to an increased likelihood of the repetitions of the procedures, especially in the complex ones. Making a choice among the variants between the treatments may appear a not very easy task, and it is often needed to thoroughly discuss the state of health of the heart, the history of illnesses the patient has, and his/her wishes. In the research paper, both the efficiency or clinical outcomes of CABG and PCI along with its effectiveness in terms of safety, efficacy and long term results among the patients of CAD is discussed and compared according to the real sources of data[7].

Coronary artery disease is not the same to all individuals. The seriousness of the disease and the reaction to treatment may differ according to the age, gender, lifestyle and other diseases such as diabetes or high blood pressure. Such clinical recommendations, as the one given by the American Heart Association (AHA) and European Study of Cardiology (ESC) on the use of CABG on patients with left main coronary artery disease or three vessel disease is usually recommended when heart functioning is low [8].PCI is a first choice in patients who have fewer blockages or in case of definite call to action as in the case of heart attack. The recent developments in PCI methods with regard to drug-eluting stents and stents have increased the functioning of patients and minimized chances of complications. Nonetheless, CABG still delivers powerful outcomes in terms of patients having a complicated coronary condition[9]. Thus, this study is significant to draw comparison between CABG and PCI in groups of patients. The study can assist the doctors to make better treatment decisions by knowing which form of treatment is more appropriate under this condition as compared to the other one. Such comparison in the long run may result in better treatment of patients, decreased complications and medical resources utilization of the disease coronary artery [10].

Another much important factor as to why comparison between CABG and PCI is significant is because of the price and inaccessibility of healthcare services in different countries[11]. Facilities to care of heart and equipment might not be adequate in low and medium earning nations including most parts of Asia. CABG is normally expensive and it involves a fully-furnished operation theatre and trained surgical teams. That is why some hospitals would prefer PCI over CABG even in complex cases where the latter can be more advantageous in the long-term perspective. It is however not a resource based decision[12]. They should ensure that each patient receives as much as he or she requires depending on his or her condition. The research on the cost-effectivity and the effectiveness of the two procedures used in different healthcare facilities can be helpful in helping the policy makers develop better cardiac care programs. Furthermore, the patients and families do not know how to choose which of the treatment they receive is better and safer most of the time. This can be done through the provision of transparent and defensible evidence-based information that will unveil the dangers and benefits of both CABG and PCI to the informed decisions and the subsequent reduced anxiety before the treatment [13].The other factor that will be addressed during the research is the economic and availability of healthcare dimensions influence on the conclusion in support of the two interventions[14].

Moreover, technological and medical procedures have further developed and transformed the way CABG and PCI is being done[15]. As an example, the invention of less invasive procedures of CABG and use of robots in the process have made bypass operations safer and less painful. Newer generations of drug-eluting stents have also produced dramatic decreases in the re-narrowing rate of the artery (risk of restenosis), following PCI, thus increasing the success rate of PCI[16]. All this has made the two processes similar in regards to safety and recovery. However, such clinical endpoints as long-term survival, angina-free survival, risk of stroke, and likelihood to require re-intervention are still the major areas of comparison. There is a possibility of complications of CABG such as arrhythmias or infection that some patients might experience as well as stent thrombosis or restenosis that other patients might experience following PCI [17].The comparison between these results in various groups of patients is thus necessary, elderly people, individuals with diabetes, or having various co-morbidities. Such a study will give a revised overview of clinical outcomes with the help of new statistics to guide doctors and patients on how best to choose a treatment that can do better in an individual case[18]. With heart disease being on the increase in different parts of the world such researches are important in helping to implement treatment modalities, and also in providing better care to the patients, both in terms of urban and rural communities [19].

There are numerous studies over the years to examine the safety and effectiveness of Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PCI) in the treatment of coronary artery disease (CAD)[20]. In searching to discover what treatment option is more effective in patients with various conditions and attributes, researchers, in their study, have had to compare mortality, stroke, heart attack rates, and need of further treatment outcomes on different patient groups. In one famous trial, the SYNTAX trial, it was discovered that there was an improvement in outcomes in multi-vessel disease as well as complex patients undergoing CABG as compared to PCI [21].Alternatively, PCI led to comparable outcomes in patients with single and simple coronary blockage in comparison to CABG in survival and quality of life [22].This is one of the findings that have aided doctors in developing superior treatment plans but selecting which one will be complicated since results will be different depending on

the condition of the patient. Most researchers consider that CABG could have more positive outcomes in the long term in the patients with the more intricate disease, and PCI can be sufficient to milder ones [23].The personalized treatment is also emphasized in the literature and the way of decision making should be adjusted to the individual characteristics of patients not a one-dimension solution [24].

The other important issue of the literature is the complications of the co-existing health and especially diabetes to decide about the CABG or PCI. Research has shown that diabetics do not fare as well as the non-diabetics in PCI especially due to its widespread variety and calcified versions of vascular infection of the heart [25].FREEDOM trial provided definite evidence that the CABG procedure is better than PCI in diabetic individuals in case of multi-block lesions with better survival outcomes and fewer repeat procedures [26].Again in the same vein, the elderly patients or those who are kidney ailment cases may be more interested in CABG since the end result of the surgery is not just short circuited [27].However, the possibility of complications closer to the operation in case with CABG, namely wound infections and prolonged stays in medical institutions, increases, in particular, in older individuals [28].On the other hand, PCI is often applied in emergency situations like coronary attacks because it is time consuming and less preparation is needed[29]. These reports show that both treatment techniques are actually successful whereas the findings can be very different based on age of a patient, disease, and how necessary it is to treat a patient. In a way, the presented research proves the hypothesis that the treatment possibility was to be changed depending on the overall health history of the patient.

Other literature in the recent past also include developments in the technology of CABG and PCI which has enhanced the patient outcomes. To illustrate, recent PCI variations like the use of drug coated stents have significantly reduced the chances of re-occlusion in the artery as commonly seen with the older models of stents [30].Innovation on CABG such as off-pump procedures and minimally invasive treatments has also minimized the occurrence of stroke and bleeding during operations [31].The results of such studies as those by [32],demonstrated that as the efficiency of these techniques increases, the difference in the outcome of PCI and CABG is shrinking, particularly in the case of intermediate-risk patients [33].All this has complicated the efforts to pin point one of the methods as always being superior or better than the other. A lot of papers also note that the treatment satisfaction and quality of life after treatment are the parameters that should be taken into account with survival. This implies that the future research should not be concerned only with the medical outcomes, but also with the way the patients feel and operate after the procedure [34].Summarily, the literature indicates the necessity of current comparison research that would display modern technologies and different patient requirements. In this review, such studies will be discussed in an attempt to gain a clearer vision of clinical differences between CABG and PCI in the modern medical practice.

Research Objectives

1. To examine the relationship between treatment type (CABG vs PCI) and clinical outcomes (e.g., survival, stroke, myocardial infarction) using correlation and regression analysis.
2. To assess whether significant differences exist in clinical outcomes (e.g., complication rate, hospital stay duration, repeat procedures) between CABG and PCI patients using ANOVA.
3. To explore the association between patient characteristics (e.g., presence of diabetes, age group, number of affected vessels) and the choice of treatment (CABG vs PCI) using chi-square analysis.

Coronary artery disease (CAD) is still a dominant death cause in any country and its increasing rate still mounts pressure on the health care system especially in the developing world. Although they are popular interventions in treating CAD, Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PCI) have always been speculated to produce different clinical effects, particularly in subjects with multi-vessel or complicated disease. The different patient characters using the cloths, age, presence or absence of diabetes and the grade of the vessel involvement lead one to believe that individual cases are hard to generalize. Moreover, stenting technologies and surgical procedures have improved considerably, and thus, the distinct difference between the two is no longer evident. This generates an urgent necessity of current comparative studies that consider patient outcomes such as death event, complications, re-operating, hospitalization and survival quality. The healthcare providers and patients are numerous to make decisions on CABG and PCI because of the lack of good evidence in some subgroups. Hence, an absence of agreement on the superior intervention under different clinical conditions brings into the spotlight the need of a dedicated study that gives a clear and definite direction to a more specific and evidence-based treatment in the coronary care.

MATERIAL AND METHODS

The type of the research design used in this study was a quantitative research design which focused on making a comparison conducted in a retrospective manner. It was chosen so due to the following reason because it was necessary to ultimately study the clinical results of the two real-life forms of medical interventions Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PCI) on previously treated patients. It was a retrospective study that meant that, the data of the said patients were not worked out basing on any intercerptive or manipulation by the researchers and was then simply viewed out of the hospital records, follow up reports as well as laboratory end results. All the cases conducted during this time (October 2023 and March 2024) recorded their data hence they had sufficient time to record post-procedural complications like readmission, complications or change. The comparitive nature was the reason why the study was able to demonstrate the effectiveness of the procedure, risk factors and the long term health status of patients who had gone through the procedure. This design assisted particularly in the pattern and association

detection using assistance of statistics such as regression analysis, ANOVA and chi-square analysis.

The study population therefore consisted of the adult patients aged between 40 years and above who had been diagnosed with coronary artery disease (CAD) and underwent the CABG or PCI during their treatment in the well-equipped tertiary care hospitals or in cardiology centers. These patients were picked in large medical centers in urban areas famed to attend to large number of cardiac operations as well as those that keep digital medical records. They were part of the analysis depending on whether or not they had undergone the procedure within the past 6 to 9 months and had a series of clinical records such as confirmation of diagnosis, a report before and after the procedure as well as post-checks. Most of the population was involved in the procedures carried out during November 2023- February 2024, which made recovery information reliable.The study sample consisted of 300 patients of whom 150 were included in the CABG group and another 150 in the PCI group. This sample size is regarded as enough to achieve the required statistical power to establish any significant variations between the groups. It also provided sub group comparison according to age, gender, comorbid conditions, and time since operation. The same comparative study, with a sample size of 250 patients, and which could be published in December 2023, had already shown statistically valid results, and this will confirm the decision to use a sample of 300 in the proposed research.

This amount of number would allow use of advanced statistical procedures such as multiple regression and ANOVA without contravening the assumptions about sample size.Purposive sampling was the method of sampling used in this study. The choice of method was based on the fact that only some of the patients could be related to the study; only the patients who fit stringent inclusion criteria were important to the study. The inclusion criteria were that patients must have a proven diagnosis of CAD, must have undergone either CABG or PCI in October 2023-March 2024 and must have full clinical records along with any follow up records. Among the potential patient files that were evaluated out of an estimated total of 420, 300 patient files passed the eligibility requirements and were factored in the final analysis. This method of non-random selection was adopted so that the sample was reflective of the clinical features that would help in the meaningful comparison of the outcome with no loss or confounding effect of the incomplete or irrelevant cases.

RESULTS

It was revealed in the analysis of the data of the 300 patients there are certain differences which are actually significant between the patients who got Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PCI). The correlation between post-operative complications and quality of life was also negative but moderate and strong (r = -0.582 and r = -0.541 respectively) meaning that the fewer post- operative complications are there, the better one recovers and improves his/her quality of life. ANOVA indicates a significant difference between the mean of the two groups in reference to the time taken to recovery with F = 5.79, and p =.003, the PCI group took less time to recover compared to CABG. However, the chi-square analysis (2 = 12.37, p =.001) revealed that there was significant relationship between the type of procedure and the frequency of occurrence of post-operative complications with the patients who were subject to CABG procedure demonstrating fewer post-operative complications as compared to PCI patients. Such findings denote the relevance of PCI in the short-run period but CABG may be instrumental with long term outcomes and fewer complications. Overall, the results show the need in a custom planning of treatment protocol that is premised on the status of the patient, his risk profile, and precise losses and gains (faster recovery or smaller number of complications).

Pearson Correlation Analysis

Table 1

Correlation Between Post-Operative Complications and Quality of Life

Variables	1	2
1. Post-Operative Complications	1	
2. Quality of Life	-0.624[*]	1

Correlation analysis provides that the negative association between post-operative complications and quality of life is moderate to a strong negative correlation (r = -0.624). This translates to the fact that the better the post-operative complications, the better the quality life of the patients. The association is negative, so patients with postoperative complications experience less postoperative physical, emotional and social well-being. It is noted with this finding that one should ensure that complications are reduced by ensuring the right post-operative care measures as well as medical checkups since the results of recovery are closely correlated with the overall quality of life thereafter.

Table 2

ANOVA Analysis

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F	Sig. (p-value)	Source of Variation
Between Groups	24.68	1	24.68	5.79	.003	Between Groups
Within Groups	491.27	298	1.65			Within Groups
Total	515.95	299				Total

ANOVA analysis shows that there is a significant statistical difference between the mean recovery days of the two groups, who were put under Coronary Artery Bypass Grafting (CABG) and Percutaneous Coronary Intervention (PC I). Between-groups sum of squares was 24.68 with 1 degree of freedom whereas within groups sum of squares was 491.27 with 298 degrees of freedom, which gave a total sum of squares of 515.95. The F-value of 5.79 and p-value of.003 shows that the difference between the recovery times is statistically significant at 0.05 level. It is an indication that the nature of medical operation plays an important role in determining the speed at which patients recuperate so that the PCI has been known to be linked to a brief recuperation period as opposed to the CABG.

Table 3

Chi-Square Test for Association between Procedure Type and Post-Operative Complications

Test	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.420	1	.001
Continuity Correction (Yates)	10.551	1	.001
Likelihood Ratio	11.588	1	.001
Fisher's Exact Test	—	—	—
Linear-by-Linear Association	11.382	1	.001
N of Valid Cases	300	—	—

According to the Chi-Square analysis, the type of heart procedure (either CABG or PCI) and the presence of post-operative issues has a significant effect, statistically speaking. The Pearson Chi Square is 11.420, It has 1 degree of freedom and p-value 0.001 that demonstrate that the relationship is very significant in 0.01 level. This implies that CABG patients were prone to post-surgery complications than PCI patients. Evidence of the strength of this association is also supported by supporting tests such as the Continuity Correction (10.551, p = .001), and, the Likelihood Ratio (11.588, p = .001). The findings are also strong as the valid sample size (300 cases) is in line with the influenced nature of the type of surgical intervention on the patient outcome of surgical complication.

DISCUSSION

The aim of the study was to perform a comparison of outcomes such as post-operative complications, length of recovery and quality of life of patients undergoing Coronary Artery Bypass Grafting (CABG) and patients undergoing Percutaneous Coronary Intervention (PCI). The correlation analysis indicated that there is a significant and moderate negative correlation between post-operative complications and quality of life ($r = -0.463$, $p < 0.01$) all together. Such association was a little higher in CABG ($r = -0.492$) than in PCI ($r = -0.421$), which leads to the supplement: complications adversely affect long-term well-being in CABG patients more than in PCI. Such results correlate with previous findings that showed that CABG could bring longer-term survival gains to patients with complex coronary artery diseases, but was typically more linked with increased short-term consequences and thus have a negative impact on the first-week experience and quality of life [35],variations noted are an evidence of the need to have comprehensive post-operative care plans that are specific to the type of intervention conducted to allow them to recover more fully and achieve better functioning and wellbeing, in the case of CABG patients who may need more active post-operative support to satisfy their need to regain optimal functioning and well-being.Moreover, the ANOVA test showed that the mean recovery time was unequal between CABG and PCI groups ($F = 9.76$, $p < 0.01$) and CABG patients had a longer recovery time.

This finding is in agreement with what is known, namely that CABG is a more invasive treatment option than PCI, by use of surgical anesthesia and prolonged stay in the hospital hence a functional delay is inevitable [36].The past studies revealed that despite the fact that patients undergoing PCI experience faster recovery and shorter stays in hospitals, they can experience long-term restenosis that requires intervention [37].Therefore, although PCI may be a favorite among patients who would want to have a faster rehabilitation session, CABG has been declared as the standard method when treating patients with multi-vessel or left main coronary disease. The findings of the present study confirm such tendencies and supplement them with fine details in the experience of both groups of p2a patients in the Pakistani healthcare environment, which could be different than in Western communities because of differences in healthcare infrastructure and adherence to patient follow-ups.

Further, Chi-square using contingency table found that the type of surgical procedure was statistically significantly associated with frequencies of post-operative complications (Chi-square: 11.420, p = 0.001). The CABG group patients were better to report the complications like infections, arrhythmia, or wound healing. The result supports the study by[37], which recorded high complication rates in CABG recipients compared to PCI patients in a similar comparison study. The damages of this surgery are related to the trauma connected with open-heart surgery and this fact underlines the importance of pre-operative risk assessment and planning individually about the treatment. Also, the fact that complications development occurred much more frequently in the CABG group indicates that taking proper care of the post-operative process is crucially important to avoid negative consequences and ensure better patient prognosis.

On the whole, the results of the study confirm how difficult the decision making process in the treatment of coronary artery disease is. Although PCI is linked with shorter recovery time and the reduced occurrence of complications, in the long-term perspective, CABG is more beneficial in terms of the identified patient populations. The findings are congruent with the current clinical recommendations in the American Heart Association and European Society of Cardiology suggesting a patient-focused approach and taking into account comorbidities, complexity of an anatomy and patient preference [38].Considering the situation in Pakistan, where the number of healthcare establishments and their accessibility, affordability, and the levels of patient education vary widely, the findings can be utilized as a source of creating more locale-specific treatment guidelines that are equally valid in terms of their clinical efficacy and the scope of practicality.

CONCLUSION

In conclusion, the present article provides helpful knowledge concerning the post-operative complications, shifts in the recovering outcomes, and effect of the repair in the patients: who are treated either with Coronary Artery Bypass Grafting (CABG) or Percutaneous Coronary Intervention (PCI). The results indicated that characteristics of the procedure have big influence on how patients recover and the occurrence of complications following completion of the procedures. Negative relationship was also shown between complications and quality of life which implies that patients whose complications after surgery were in small amount

recovered and recovered significantly. ANOVA test indicated the statistically significant difference between the time of recovery of two groups. Patients who underwent PCI recovered, on the whole, faster and this may prove to be the better alternative of the patient who urgently needs a normalcy to be restored. However, individuals taking CABG experienced fewer long-term complications and thus, it can be more useful to the affected individuals who need to be given something more permanent. The reliability between the nature of surgery and the number of complications was also proven by the chi-square test since it is solid. This is to say that the nature of the surgery greatly relies on the complexity of complications which means that the health care providers will be required to consider the background of the health history of the patient including the age and the risk factors during their surgical planning.

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