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A Comparative study on Quality of Life (QOL) Assessment, between Minimally Invasive Cardiac Surgery (MICS) CABG and Traditional CABG

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Abstract:

Background:
CABG is a surgical revascularization procedure, to restore blood flow to the heart, by introducing a graft either from legs, wrist or an internal artery, to bypass the diseased large coronary artery, which blocked the blood flow. It is only used to treat those patients who have severe CAD that could lead to heart attack. Patients undergoing CABG have two options for surgery, which are traditional bypass surgery (on pump) and minimally invasive bypass surgery (off-pump). On- pump requires to open the sternum to access heart (thoracotomy), off-pump requires a small incision in the intercostal space. Surgeons suggest either one of the surgeries to the patient with severe coronary artery disease depending on the conditions of the patient.

Aim:
To assess and compare the post-operative quality of life in the patients who underwent traditional CABG surgery or minimally invasive bypass surgery.

Methodology:
The patients who underwent CABG and MICS CABG in the past year, November 2022 to November 2023, were identified from the site-tertiary care hospital. They were selected according to inclusion-exclusion criteria**.** A retro-prospective comparative study was conducted through telephonic interviews with the patients at intervals of 12 months, 9 months, 6 months, and 3 months from their surgery. The interview was conducted using the SF-12 health-related Quality of Life questionnaire, and the respective responses were recorded.

Result:
A total of 335 patients were enrolled in this study, out of which 83% (n = 279) were males and 17% (n = 56) were females. We observed that the majority of the patients were between the ages of 61-70 years (n = 130), followed by 51-60 years of age (n = 105). The most prevalent comorbid condition seen in patients was hypertension 41% n = 204), followed by diabetes mellitus (36%; n = 180). We noted that a major portion of the population was overweight (49%), and 24% were obese. We found that 49% (n = 165) of the patients had a reduced LVEF%, 33% (n = 111) had a normal LVEF%, and 18% (n = 59) had mildly reduced LVEF% values. There was no significant difference between the LVEF% of both groups. No difference was seen in the total volume of blood administered to the patients in both groups. However, MICS CABG patients had a significantly shorter length of stay than the patients who had traditional CABG surgery. The highest number of patients (68%, or n = 226) were diagnosed with CAD-TVD. MICS CABG patients had significantly better PCS scores in each of the categories, except for the 3-month category. However, they exhibited no significant difference in the MCS scores of the 3, 6, and 12 month categories. Overall PCS scores were also significantly higher in the case of the MICS CABG group, while there was no significant difference in the overall MCS scores. Both the surgeries had more impact on the physical health of the patients than their mental health.

Conclusion:
MICS CABG surgery is associated with a better overall quality of life, predominantly the physical health status, a shorter length of stay at the hospital, and a faster rate of recovery.

I. INTRODUCTION

Cardiovascular Disease is a broad term encompassing a range of heart and blood vessel-related conditions. These includes coronary artery disease (CAD), heart failure, stroke, and more. India has a higher age-standardized death rate for CVD (272 deaths/100,000) than the rest of the world (235 deaths/100,000), and ischemic heart disease is the most prevalent cause of death in India, accounting for about 16.17% (14.87%-17.16%) of the total deaths [(1,2)].

Coronary artery disease is a common heart condition that involves atherosclerotic plaque formation in the lumen of blood vessels. This leads to impairment in blood flow and thus oxygen delivery to the myocardium decreases and is a major cause of morbidity and mortality worldwide. Coronary artery disease is the foremost cause of disability and death over the world and is one of the top five causes of death in Indian population. Prevalence of CAD in India was found to be 32.4% in the year 2020 [(3)]. Coronary artery bypass

grafting (CABG), a surgical procedure that is used to improve blood flow to the heart, has advanced to become the gold standard in the management of severe coronary artery disease.

Traditional CABG is a surgical procedure to improve blood flow to the heart muscle in patients with coronary artery disease. CAD occurs when fatty deposits (plaque) build up inside the coronary arteries, narrowing the passage and reducing blood flow to the heart. CABG creates a bypass around the blocked artery using a healthy blood vessel from another part of the body. Statistical data shows that presently, around 60,000 CABG surgeries are performed annually in India [(4)].

Recent developments in minimally invasive surgical procedures and technology have led to an increase in the use of minimally invasive cardiac surgery (MICS) CABG for the treatment of CAD. This technique eliminates the need for an open median sternotomy and instead performs CABG through a series of small chest wall incisions between the ribs [(5)]. In addition, the technique enables the procedure to be performed while the patient's heart is still beating (off-pump) rather than with induced cardiac arrest and cardiopulmonary bypass (on-pump).

II. MATERIALS AND METHODS

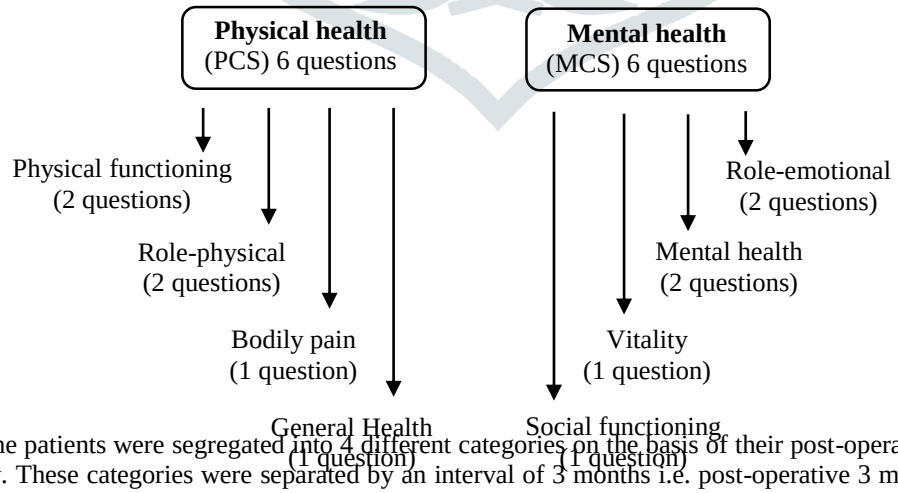
This study is a retro-prospective single-centric comparison of quality of life of the patients who underwent CABG surgery (MICS or traditional) performed by a single surgeon from November 2022 to November 2023. A total of 354 patients with coronary artery disease underwent the CABG surgery (MICS: 179 and traditional: 175). A verbal consent was taken from those patients willing to participate in the study. Interviews were conducted via telephonic means. The data included demographic details obtained from the patient's file available in the MRD of the hospital. A standard HRQoL questionnaire, SF-12, was used to ask questions to the patients based on their quality of life, and their respective responses were marked and recorded by the investigator. The permission to use SF-12 for this study was obtained from John Ware Research Group, Inc. through email.

Inclusion criteria: (i) Limited to patient who had CABG surgery either MICS or Traditional within predetermined 1 year of time frame. (ii) Patients who are willing to participate in the study.
Exclusion criteria: (i) Patients who are unable to complete the quality of life questionnaire due to language difficulties, cognitive impairment, or other reason. (ii) Patients with major complications after surgery such as paralysis, myocardial infarction, or operation failure. (iii) Patient who have undergone other type of cardiac surgery. (iv) Patient who died after surgery.

Sampling/ sample size:
- Calculated sample size: 334 (by Cochran's formula)
- Data collected: 354
- Excluded patients: 19
  - 3 deaths
  - 2 cases of paralysis
  - 1 case of operative failure
  - 3 patient's number was out of existence.

SF-12 questionnaire: The SF-12 questionnaire, which contains a total of 12 questions, is divided into two components: Physical Component Summary (PCS) and Mental Component Summary (MCS), which contains four domains each.

Figure 1 SF-12 domains



SF-12 analysis: The patients were segregated into 4 different categories on the basis of their post-operative duration status and the month of interview. These categories were separated by an interval of 3 months i.e. post-operative 3 months, 6 months, 9 months, and 12 months. The SF-12 interviews were taken according to these categories. Once the interviews were taken from 335 patients according to the categories they were segregated in, SF-12 scores were calculated, which gave us the PCS and MCS scores. Ultimately, the means of PCS and MCS scores of the MICS and Traditional groups were compared category-wise and analyzed using the statistical tests. Scores range from 0 to 100, with higher scores indicating better physical and mental health functioning. Scores above 50 indicate a better-than-average health related quality of life, while scores below 50 suggest below-average health.

Table 1 Distribution of patients according to the interview categories

Post-operative duration	No. of patients (n=335)

	MICS CABG (n=171)	Traditional CABG (n=164)	Total (n=335)
3 months	16	14	30
6 months	39	39	78
9 months	61	60	121
12 months	55	51	106

Statistical analysis: The data was analyzed using IBM SPSS software version 27. Continuous data was represented as the mean with standard deviation, while categorical variables were expressed in terms of graphs, frequencies, and percentages. The LVEF% of both groups was compared using independent samples student T-test; the level of significance was kept at $p \leq 0.05$ and CI = 95%. The length of stay at the hospital and volume of blood transfusions were compared using the Mann-Whitney U-test. The SF-12 scores of the MICS CABG group and the traditional CABG group were calculated using SPSS with the help of a syntax code, and the scores were compared by applying the Mann-Whitney U-test by keeping $p \leq 0.05$.

Data collection tools: Case report form (CRF) and SF-12 questionnaire, patient documents and records.

III. RESULTS

The patient demographics and clinical characteristics were collected and are illustrated in *Table 2*.

Table 2 Characteristics of the patients

Variables	MICS CABG (n=171)	Traditional CABG (n=164)	Total (n=335)
Sex, n (%)			
- Female	23 (13%)	33 (21%)	56 (17%)
- Male	148 (87%)	131 (79%)	279 (83%)
Age, n			
30-40 years	5 (2%)	1 (1%)	6 (2%)
41-50 years	23 (13%)	24 (15%)	47 (14%)
51-60 years	57 (33%)	48 (29%)	105 (31%)
61-70 years	67 (39%)	63 (38%)	130 (39%)
71-80 years	18 (11%)	27 (16%)	45 (13%)
81-90 years	1 (1%)	1 (1%)	2 (1%)
Mean ± Standard deviation	60.0175 ± 8.84073	61.5244 ± 9.19953	60.7552 ± 9.03618
BMI, n (%)			
- Underweight (<18.5)	1 (1%)	5 (3%)	6 (2%)
- Normal (18.5-25)	31 (18%)	53 (32%)	84 (25%)
- Overweight (25-30)	86 (50%)	79 (48%)	165 (49%)
- Obese (>30)	53 (31%)	27 (17%)	80 (24%)
Diagnosis, n (%)			
- CAD- SVD	9 (5%)	8 (5%)	17 (5%)
- CAD- DVD	38 (22%)	54 (33%)	92 (27%)
- CAD- TVD	124 (73%)	102 (62%)	226 (68%)
LVEF, n (%)			
- Normal (50%-70%)	65 (38%)	46 (28%)	111 (33%)
- Mildly reduced (41%-49%)	26 (15%)	33 (20%)	59 (18%)
- Reduced (40% or less)	80 (47%)	85 (28%)	165 (49%)

Table 3 demonstrates that from a total of 335 patients, 111 had a single comorbid condition, and 175 had multiple comorbidities. The remaining 49 patients were free of any comorbid condition. Detailed distribution of patients according to their comorbid condition is shown in the table.

Table 3 Comorbidities

Name of comorbidity	**No. of patients**			**Names of comorbidities**	**No. of patients**		
	MICS	Traditional	Total		MICS	Traditional	Total
Hypertension	23	25	48	HTN + DM	49	29	78
Diabetes mellitus	24	20	44	HTN + DM + IHD	14	15	29
Tuberculosis	1	1	2	HTN + IHD	11	11	22
Ischemic heart disease	5	7	12	DM + IHD	9	4	13
Stroke	0	1	1	HTN + DM + Thyroid	4	3	7

Cancer of buccal mucosa	0	1	1	HTN + DM + CKD	1	2	3
Chronic kidney disease	1	0	1	HTN + Thyroid	0	2	2
Thyroid	0	2	2	HTN + IHD + CKD	1	1	2
				HTN + DM + CKD + Thyroid	0	1	1
				HTN + DM + IHD + Thyroid	0	1	1
				HTN + DM + IHD + AKI	1	0	1
				HTN + DM + Dyslipidaemia	1	0	1
				HTN + IHD + COPD	0	1	1
				HTN + Thyroid + BPH	1	0	1
				HTN + DM + COPD	0	1	1
				HTN + DM + TB	0	1	1
				HTN + Psoriasis	1	0	1
				HTN + CKD	0	1	1
				HTN + COPD	0	1	1
				HTN + Arthritis	1	0	1
				HTN + CV stroke	0	1	1
				DM + CKD	1	0	1
				DM + Cancer of buccal mucosa	0	1	1
				DM + TB	1	0	1
				DM + IHD + HIV/AIDS positive	1	0	1
				IHD + COPD	1	0	1
				IHD + Unstable angina	1	0	1
Total	54	57	111		99	76	175

Out of 335 patients, 325 received some or the other kind of blood transfusion. Out of these 325 patients, 301 patients received only RBC transfusion in required volume, while the remaining 24 patients received other types of transfusions such as Platelets, fresh frozen plasma (FFP), packed cell volume (PCV), cryoprecipitate, and some received RBC in addition to the above-mentioned components too. From the total of 301 patients who solely received RBC as transfusion, 146 belonged to the traditional group and 155 to the MICS group. Next, the volume of transfusions administered to both the groups was then compared (*Table 4*). Moreover, the duration for which the patients stayed at the hospital was also compared (*Table 4*), patients who underwent traditional CABG surgery stayed in the hospital for a longer period of time than those who chose MICS surgery.

Table 4 Volume of blood transfusion and length of stay comparison

Variables	Mean ± Standard deviation		p-value
	MICS CABG	Traditional CABG	
Blood transfusion (ml)	551.0705 ± 249.13928	577.9396 ± 274.09439	0.350
Length of stay	6.9298 ± 1.36588	7.7439 ± 1.64157	<0.001*

Figure 2 demonstrates that out of 171 patients in the MICS group 64%, (n=109) scored above 50, which means that they have a better-than-average quality of life, and 36% (n=62) had scores below 50, which suggests that their quality of life is below average. Whereas in the traditional CABG group, 32% (52) had better-than-average physical health, and 68% (n=112) had below-than-average physical health quality.

Figure 2 Distribution of patients according to their PCS scores in the MICS and the traditional CABG group.

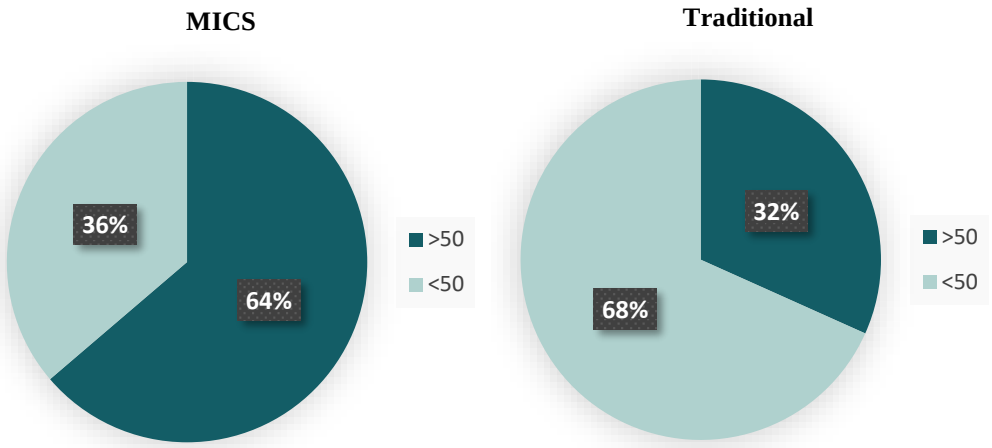
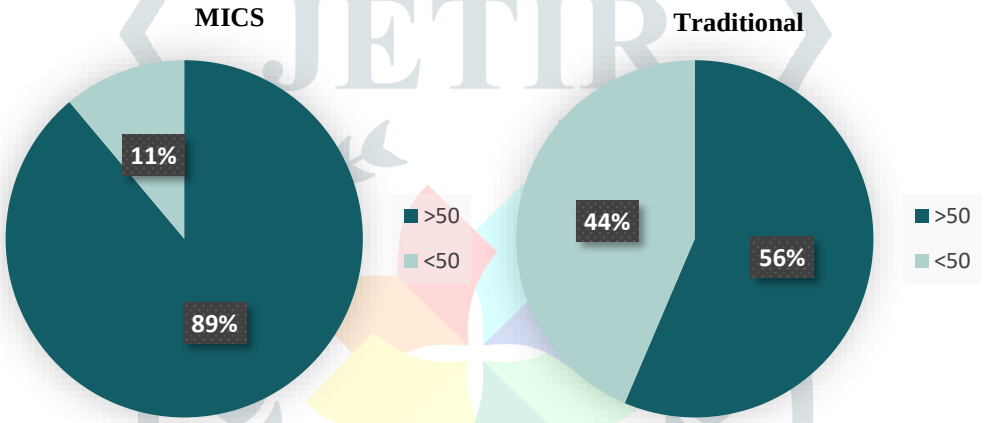


Figure 3 depicts the MCS scores, which revealed that in the MICS group, 89% (n=152) of the patients had above-average mental health quality, while only 11% (n=19) had below-average mental health. In the traditional CABG group, 88% (n=145) experienced an above-average mental health quality, and the remaining 12% (n=12) had MCS scores below 50.

Figure 3 Distribution of patients according to their MCS scores in the MICS and the traditional CABG group



The SF-12 score calculation and comparison between both groups revealed that the PCS scores of the MICS group were significantly higher than that of the traditional CABG group in every category including the overall PCS score, except for the post-operative 3 months category which showed no significant difference. As for the MCS scores, no significant difference was observed across any of the categories. Table 5 demonstrates the mean scores and standard deviations along with the p-value for each class.

Table 5 Quality of life assessment and comparison

Categories	Mean ± Standard deviation		p-value
	MICS CABG	Traditional CABG	
Post-operative 3 months - PCS - MCS	 52.7262 ± 4.88371 59.0350 ± 5.81009	 49.4271 ± 7.10577 60.3693 ± 2.90624	 0.193 0.667
Post-operative 6 months - PCS - MCS	 50.0136 ± 7.81819 58.2985 ± 5.84819	 45.0846 ± 8.50940 56.2656 ± 9.82294	 0.002* 0.869
Post-operative 9 months - PCS - MCS	 49.8584 ± 7.41778 58.6595 ± 6.64244	 39.4002 ± 8.03577 60.2980 ± 6.86553	 <0.001* 0.043*
Post-operative 12 months - PCS - MCS	 49.8418 ± 8.56244 59.0664 ± 6.76078	 45.9129 ± 9.37035 57.3133 ± 8.76847	 0.024* 0.551
Overall - PCS - MCS	 50.1568 ± 7.69195 58.7432 ± 6.38786	 43.6332 ± 9.10077 58.4170 ± 8.18123	 <0.001* 0.235

Table 6 PCS vs MCS scores

Type of surgery	PCS score	MCS score	p-value
MICS CABG	50.1568 ± 7.69195	58.7432 ± 6.38786	<0.001*
Traditional CABG	43.6332 ± 9.10077	58.4170 ± 8.18123	<0.001*

The MCS scores of either of the surgeries are higher than their respective PCS scores.

Table 7 Detailed PCS scores comparison

Domain name	Mean ± Standard deviation		p-value
	MICS CABG	Traditional CABG	
Physical functioning	-0.7282 ± 1.51782	-1.2221 ± 1.93761	<0.001*
Role-physical	-1.1267 ± 2.12155	-2.2399 ± 2.53798	<0.001*
Bodily pain	-0.3428 ± 1.18048	-0.8156 ± 1.95702	<0.001*
General health	-0.1600 ± 0.58753	-0.3041 ± 0.91063	<0.001*

Because there was a significant difference between the PCS scores of the MICS and the traditional group in the post-op 6 months, 9 months, and 12 months, we decided to further analyze PCS of the patients domain-wise, which is depicted in *Table 6*

IV. DISCUSSION

Minimally invasive cardiac surgery has gained popularity as a safe alternative to traditional cardiac surgery. MICS CABG was developed to enable sufficient exposure and revascularization from a small thoracotomy incision without cardiopulmonary bypass. Numerous studies have reported that compared to patients who had a sternotomy CABG, MICS CABG patients had a noticeably shorter hospital stay and a faster physical recovery after surgery. However, no compelling scientific trial has shown that patients undergoing MICS CABG had an improvement in their quality-of-life following surgery when compared to conventional CABG. Our study is aimed at assessing and comparing the quality of life of patients who underwent MICS CABG and traditional CABG. This study found that out of 335 patients who underwent CABG surgeries, 83% were males and 17% were females (Table 2). This is consistent with a study by Kaul et al., which found that out of 6,250 patients, 21.4% were women and 78.6% were men, with the number of men and women presenting for CABG not significantly changing over the years. [(6)]

Sanchis-Gomar et al. performed a study to summarize the incidence, prevalence, trend in mortality, and general prognosis of coronary heart disease (CHD) and a related condition, acute coronary syndrome (ACS), and found that CAD prevalence increases after 35 years of age in both men and women. The lifetime risk of developing CAD in men and women after 40 years of age is 49% and 32%, respectively. (7) In addition, findings from a study conducted by Peric et al. in 2015 revealed that among patients undergoing CABG surgery, 80% of them were male, with a mean age of 58.3 ± 8.3, and 20% were female, with a mean age 61.6 ± 6.1. The age distribution was as follows: 16% patients were <50, 35% were 50–59, 40% were 60-69, 9% patients were 70 or older. (8) Our findings reveal a similar trend, the maximum number of patients who underwent the surgery (39%) were between the age of 61-70 years, followed by 31% of them falling between the age group of 51-60 years, 14% in 41-50 years age group, 2% in 30-40 year age group and only 1% had age between 81-90 years (Table 2). The mean age being 60.7552 ± 9.03618.

An observational study on the demographic profile, clinical characteristics, and medical management patterns of Indian coronary artery disease patients carried out by Khan et al. in 2021 revealed that the majority of the patients with both stable IHD and ACS had underlying comorbidity/medical conditions including hypertension (59%), followed by diabetes mellitus (57.6%), CKD (5.9%), and dyslipidaemia (4.4%). (9) In this study, we found that, like the study by Khan et al., the most prevalent comorbid condition seen in patients was hypertension 41% (n=204), followed by diabetes mellitus (36% or n=180). In addition to that, IHD accounted for 17% (n=84) of the total patients, 3% (n=14) had thyroid conditions, and other comorbidities such as CKD, TB, and stroke were also observed in minor proportions. Out of 335 total patients, 111 had a single comorbid condition, 175 had multiple comorbidities and 49 suffered with no comorbidities (Table 3).

According to the Krishnan et al. study in Kerala, south India, involving 5167 adults with CAD, being overweight or obese was detected as a risk factor in 59% of the total population. (10) Comparatively, in our study, a major portion of the population was overweight (49%), 24% were obese, 25% of the patients were within the normal BMI range, and only 2% were underweight (Table 2).

MICS CABG is associated with a shorter length of stay when compared to traditional CABG surgery. (11) We discovered that the mean length of stay for patients who had MICS CABG was 6.9298 ± 1.36588 days, while for those who had traditional CABG surgery, it was 7.7439 ± 1.64157 days. On applying the Mann-Whitney U-test ($p<0.05$, CI=95%), we found that patients who underwent MICS CABG had a significantly shorter length of stay when compared to the traditional CABG group (Table 4). This result can be used to support the claim that MICS patients have a faster recovery rate.

Out of 335 patients, 325 received blood products for surgery compensation. The majority (301/325) were given red blood cells (RBC) as a blood transfusion. The mean volume of RBC transfusion for MICS CABG patients was 551.0705 ± 249.13928 ml, while for the traditional group, it was 577.9396 ± 274.09439 ml. No significant difference was found between the volume of blood transfusions (Table 4).

In this study, the highest number of patients (68%, or n=226) were diagnosed with CAD-TVD, 27% (n=92) with CAD-DVD, and the remaining 5% (n=17) with CAD-SVD. Other conditions such as (ACS)- NSTEMI, ACS-unstable angina, left ventricular hypertrophy, anterior wall myocardial infarction, and inferior wall myocardial infarction were also diagnosed along with CAD-TVD, DVD, and SVD (Table 2). Our result bears resemblance to a descriptive cross-sectional study performed by Sharma et al., which also showed that the prevalence of CAD-TVD was the highest among the patients undergoing CABG surgery, followed by CAD-DVD and CAD-SVD. [(12)]

In the case of PCS scores, out of 171 patients in the MICS group, 64% scored above 50 which means that they had a better-than-average quality of life, and 36% had scores below 50, which suggests that their quality of life is below average. Whereas in the traditional CABG group, 32% had better-than-average physical health, and 68% had a below-average physical health. MCS scores revealed that in the MICS group, 89% of the patients had above-average mental health quality, while only 11% had below-average mental health. In case of the traditional CABG group, 88% experienced above-average mental health quality, and the remaining 12% had MCS scores below 50. Statistical analysis of the SF-12 score was done using the Mann-Whitney U-test, keeping $p<0.05$

and a CI of 95%. After comparing the overall PCS and MCS scores of between both groups we learned that the patients who underwent MICS CABG surgery had significantly higher PCS scores than the traditional CABG group, and hence, a better quality of physical health. However, in the case of MCS scores, we discovered that there was no significant difference between the quality of mental life of both groups (Table 5).

A comparison between the PCS and MCS scores of both groups was also drawn, which revealed that there was a significant difference between the PCS and MCS scores of both groups. This result implies that the patient's physical health quality was impacted more than their mental health because of the CABG surgery, either MICS or traditional (Table 6).

We then categorized patients into post-op 3 months, 6 months, 9 months, and post-op 12 months on the basis of their post-operative duration until the date of the interview to get more thorough results. Our research revealed that, except for the post-op 3 months category ($p=0.193$), in the remaining 3 categories, PCS scores of the MICS CABG group were significantly higher than those of the traditional CABG group. Whereas in terms of MCS scores, only the patients in the post-op 9 months category showed a significant difference in scores($p=0.043$), where patients from MICS group had higher scores and hence a better quality of life than the other group (Table 5).

We further analysed and compared the scores of 6 individual questions that fell under the PCS section of the questionnaire on the basis of responses given by the patients. The results were consistent, with patients who had MICS CABG having a significantly superior physical health quality than the traditional CABG group (Table 7).

V. LIMITATIONS

This study has certain limitations: Due to shorter study duration, we weren't able to conduct multiple interviews and follow-ups with the same patient. We weren't able to collect adequate data on patients who had recent surgery (1 month prior to the data collection start date). MICS CABG is a relatively newer technique to perform surgery; hence, not many hospitals are equipped with it. In addition to that, we also faced issues getting approval for data collection from some hospitals, therefore, we were not able to perform a multi-centric study.

VI. CONCLUSION

On the basis of our findings in this study, we can conclude that the patients who underwent MICS CABG surgery had a better overall quality of life, predominantly superior physical health, and a similar mental health quality than the patients who had the traditional CABG surgery. We also discovered that the surgery had a greater impact on the physical health of the patients than their mental health status. In addition, patients from the MICS CABG group had a comparatively shorter post-operative length of stay, suggesting that they had a faster rate of recovery than the traditional CABG group. The volume of blood transfusions administered to both groups was not significantly different. These observations suggest that, in terms of the post-operative quality of life of patients, MICS CABG has a better outcome and comes with the advantage of a shorter recovery time.

VII. ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Dr. Jaydip Ramani, cardio-thoracic and vascular surgeon at plexus heart surgery center, for his invaluable guidance and for granting us permission to collect data from the hospital, which was fundamental to the successful completion of this research.

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