

EFFECT OF YOGA BASED CARDIAC REHABILITATION AFTER CORONARY ARTERY BYPASS SURGERY IN PATIENTS OF CORONARY ARTERY DISEASE WITH MODERATE-SEVERE LEFT VENTRICULAR DYSFUNCTION

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Abstract

Background: To evaluate the effect of yoga based cardiac rehabilitation (YBCR) on exercise capacity, quality of life and modifiable risk factors in patients of coronary artery disease with moderate to severe left ventricular dysfunction undergoing coronary artery bypass graft surgery (CABG). **Materials and Methods:** In this prospective randomized controlled trial, 110 subjects were recruited (10 dropped out of the study, 5 from each arm) and randomized into Intervention arm who underwent YBCR in addition to the physiotherapy based cardiac rehabilitation (PBCR). The control group received only the standard physiotherapy care under PBCR. There were two assessment point i.e. Baseline (3rd month post CABG) and at 6th month (9th month post CABG) of recruitment. Both the groups were compared using the STATA statistics package (version 14.2). **Result:** After 6 months, body weight, Fasting Blood Sugar (FBS), High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Triglyceride (TG), LDL/HDL ratio, high sensitivity C Reactive Protein (hs-CRP), Perceived Stress Scale (PSS), Negative Affect Scale of Positive and negative Affect Score (PANAS) significantly decreased ($p < .05$) in patients undergoing YBCR+PBCR. There was also a significant ($p < .05$) increase in World Health Organization Brief Quality of life (WHO-QOL BREF SCORE), Positive Affect Scale of Positive and Negative Affect (PANAS) Score, Six Minute Walk test, and left ventricular ejection fraction (LVEF). **Conclusion:** A significant reduction in weight, LDL, triglyceride, hsCRP, PANAS negative social scale score with significant improvement in biochemical, stress scale scores, echocardiographic, and functional outcomes with yoga based cardiac rehabilitation as an add on therapy to standard physiotherapy.

INTRODUCTION

World Health Organization (WHO) has cautioned regarding increasing trend of cardiovascular diseases.^[1] The Macroeconomic Commission for Health estimated that the absolute number of IHD patients in India will increase from 36 million in 2005 to 62 million in 2015 (a $\approx 70\%$ increase).^[2] The mortality pertaining to CAD is early in Indians in their most productive age group.^[3,4,5,6] Yoga not only builds physical strength through exercises, postures, breathing exercises which covers most of the requirements of conventional cardiac rehabilitation regimen but also provides unique avenues for meditation and relaxation practises

reducing stress and achieving moderation in lifestyles.^[7,8,9,10]

MATERIALS AND METHODS

Aims & Objectives

To evaluate the effect of YBCR alone versus (YBCR + PBCR) on 6-minute walk test (MWT), Quality of life (QOL), over a period of 6 months. Also intergroup and intragroup comparisons were made regarding inflammatory/metabolic/anthropometric /stress related parameters.

Inclusion Criteria

1. Patients with established double or triple vessel disease having undergone CABG with moderate to severe left ventricular systolic dysfunction,

- Atleast 3 months' interval between surgery and recruitment to allow for sternal healing,
- NYHA Functional Class I /II,
- Between 35 and 65 years of age,
- Patients consenting to participate.

Exclusion Criteria

- Emergency CABG
- CABG with valve surgeries
- Acute / Chronic renal failure with or without dialysis
- Active decompensated Heart Failure
- Left ventricular Ejection Fraction <25%
- Physical disabilities that would prevent them from doing Yoga practices
- Neuro-psychiatric illness
- Patients already practicing Yoga
- Patients who are not ready to abstain from alcohol, smoking, or tobacco products in any form.
- Participating in any other trial, or receiving any additional alternative therapy

We conducted a prospective randomized controlled trial with two assessment point i.e. Baseline (3rd month post coronary artery bypass surgery) and at 6th month (9th month post coronary artery bypass surgery) of recruitment. The subjects were recruited from Out Patient Department (OPD) of the

Department of CTVS, after which they were randomly divided into two groups with an allocation ratio of 1:1 with computer based randomisation. (Figure 1) All the patients followed the standard physiotherapy care. The Intervention arm underwent YBCR in addition to the physiotherapy (YBCR+PBCR), whereas, the control group received only the standard physiotherapy care (PBCR).

Sample Size

The sample size of 55 is estimated in each group as it is a phase I trial with pilot study for study of benefits of yoga in patients with moderate or severe left ventricular dysfunction.

Ethical considerations

The ethical approval was taken from the institutional ethical committee. The trial was registered at Clinical Trial Registry of India (CTRI), New Delhi.

The Intervention group (Yoga and Physiotherapy Group)

The patients randomised to study arm were administered Yoga practises add-on to the standard physiotherapy regimen taught at time of discharge to ensure that time tested physiotherapy based cardiac rehabilitation is not withdrawn from the patients [Table 1].

Practices	Particulars	Duration minutes	Specific Benefits
Loosening Exercises	<ol style="list-style-type: none"> Musthika Bandhan Manibandha naman & chakra Kehuni naman Skandha chalan Griva sanchalan Janu naman Goolf naman & chakra Padanguli naman 	10	<ol style="list-style-type: none"> Breaks lethargy Loosens the tissues Develop awareness of the parts Improves concentration
Breathing Exercises	<ol style="list-style-type: none"> Hands stretch breathing with "A", "U", "M" kara chanting Tadasana with breathing Marjari Asana with breathing 	10	<ol style="list-style-type: none"> Prepares for safe practice Synchronizes body mind and breathing Maintains concentration Improves breathing capacity
Asanas		10 (3+4+2+1)	
Standing	<ol style="list-style-type: none"> Ardha kati chakrasana Kati Chakrasana 	3	<ol style="list-style-type: none"> Deepen internal Awareness and concentration Prayatna shaithilya- Local Relaxation 3. Release prana blocks Anantasamaapatti- Activates joint and muscles sensors Improve Blood flow
Sitting	<ol style="list-style-type: none"> Vakrasana Uthana mandukasana 	4	
Prone	<ol style="list-style-type: none"> Bhujangasana 	2	
Supine	<ol style="list-style-type: none"> Supta Udarakarshana asana 	1	
Pranayama	<ol style="list-style-type: none"> Yogic Breathing Nadisudhi pranayama Bhramari pranayama 	minutes	<ol style="list-style-type: none"> Control over breath Expansion of Pranayama kosha Reduces stress levels
Relaxation Technique	Deep Relaxation Technique (DRT)	10	<ol style="list-style-type: none"> Reduces stress Gives rest to the whole body

Control group (only physiotherapy group)

The patients randomised to control arm of the study continued with the standard physiotherapy regimen (PBCR).

Module of Physiotherapy based cardiac rehabilitation program (PBCR)

- Breathing practices- 10 minutes- Physiotherapy exercises for wrist, back of hand, elbows, neck, back and legs.
- Breathing exercises –15 minutes -Inhale through the nose and exhale forcibly through the mouth, Breathing through lung exerciser, additional Physiotherapy exercises for (wrist, back of hand, elbows, neck, back, legs, Shoulder rotation, slow

- side bending, knee cap tightening) and supine rest.
- Additional Physiotherapy exercises- 20 minutes (Standing position practices) -Free walking, sitting in a chair, Chakki chalana, Ankle bending, Toe Bending, Leg spread exercises with support – sideways & front and back, Supine rest.

Statistical Analysis

The data will be extracted as per the standard operating procedures. Availability of data and material all the data and material is maintained in SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, Ill., USA). The analysis was performed using the STATA statistics package (version 14.2). All data was inspected statistically for normality (skewness and kurtosis).

RESULTS

Demographic Variables

There was no significant difference in baseline height (p= weight (p=0.77), BMI (p=0.57) and waist hip ratio (p=.23) between the 2 groups suggesting well matched groups. After 6 months' significant difference is obtained within each of the individual PBCR and PBCR+YBCR groups in weight, height and waist hip ratio parameters. Significant weight reduction (p=.04) was observed suggesting positive impact of YBCR+PBCR regimen [Table 2].

Table 2 Modifiable Demographic Variables in YBCR+PBCR and PBCR groups pre and post intervention

Demographic Variables		YBCR+PBCR (n=50)	PBCR(n=50)	p value (between groups)	Effect size (95% C.I.)
Weight (kgs)	baseline	78.98±11.81	79.67±12.7	0.77	0.41(0.01,0.80)
	6 months	72.8±10.9	77.66±12.48	0.04*	
	p value (within group)	<.0001*	<.01*		
BMI(kg/meter ²)	baseline	28.19±4.57	27.7±4.11	0.57	0.24(-0.14,0.64)
	6 months	25.98±4.20	27±4.05	0.21	
	p value (within group)	<.0001*	<.01*		
Waist Hip Ratio	baseline	0.93±0.07	0.91±0.06	0.23	0.16(-0.22,0.55)
	6 months	0.89±0.05	0.90±0.06	0.41	
	p value (within group)	<.0001*	<.01*		

Biochemical / Quality of Life / Exercise capacity parameters

Significant intragroup and intergroup decrease in fasting blood sugar levels were observed in both the groups suggesting positive impact of cardiac rehabilitation programmes based on physiotherapy and as well as yoga. Yoga has additive advantages in reducing fasting blood sugar in patients post CABG [Table 3] [Table 4] [Table 5].

Table 3 Fasting Blood sugar in YBCR+PBCR group versus only PBCR group pre and post intervention

Outcome variables		YBCR+PBCR (n=50)	PBCR(n=50)	p value (between groups)	Effect size (95% C.I.)
Fasting Blood Sugar(FBS)	Baseline	119.44±19.77	110.08±18.25	0.01*	0.88(0.47,1.29)
	6 months	92.04±9.04	101.48±12.00	<0.0001*	
	P value (within group)	<.0001*	<.01*		

Table 4 Lipid profile YBCR+PBCR group versus only PBCR group pre and post Intervention

Outcome Variables		Ybcr+Pbcr (N=50)	Pbcr(N=50)	P Value (Between Groups)	Effect Size (95% C.I.)
Tc (Mg/Dl)	Baseline	129.78±29.67	138.28±47.4	0.28	0.19(-0.19, 0.58)
	6 Months	127.78±26.84	134.92±43.5	0.32	
	P Value (Within Group)	0.32	0.16		
Hdl(Mg/Dl)	Baseline	33.2±6.50	34.16±6.61	0.46	-1.69(-2.15 , -1.23)
	6 Months	50.56±7.01	38.88±6.74	<0.01*	
	p value (within group)	<.0001*	<.0001*		
LDL(mg/dl)	Baseline	80.52±26.19	90.2±40.43	0.15	0.51(0.11, 0.91)
	6 months	67.8±21.86	83.71±37.61	0.01*	
	p value (within group)	<.0001*	<.01*		
VLDL (mg/dl)	Baseline	15.56±10.99	14.54±9.89	0.62	0.27(-0.12, 0.66)
	6 months	9.66±6.82	11.84±9.02	0.17	
	p value (within group)	<.0001*	<.01*		
TG(mg/dl)	Baseline	176.5±55.41	186.66±59.4	0.37	0.74(0.33, 1.15)
	6 months	134.68±34.86	166.32±48.7	<0.001*	
	p value (within group)	<.0001*	<.0001*		
LDL/HDL	Baseline	2.54±1.08	2.65±1.10	0.63	1.06(0.64, 1.48)

	6 months	1.36±0.45	2.2±1.02	<0.0001*	
	p value (within group)	<.0001*	<.0001*		

Table 5 hsCRP, stress scales, physical score scales, MWT and LVEF in YBCR+PBCR group versus only PBCR group pre and post intervention

Outcome variables		YBCR+PBCR (n=50)	PBCR (n=50)	p value (between groups)	Effect size (95% C.I.)
hsCRP(mg/L)	baseline	3.64±0.76	3.54±0.60	0.46	0.76(0.35, 1.16)
	6 months	2.85±0.56	3.30±0.60	<0.001*	
	p value (within group)	<.0001*	<.0001*		
WHO-QOL BREF score physical	baseline	53.06±9.52	52.68±9.43	0.84	-0.80(-1.2, 0.38)
	6 months	67.66±10.16	59.1±11.06	<0.001*	
	p value (within group)	<.0001*	<.0001*		
WHO-QOL BREF score psychological	baseline	38.82±8.07	40.94±7.21	0.16	-1.16(-1.58, -0.73)
	6 months	53.44±5.52	45.78±7.47	<0.001*	
	p value (within group)	<.0001*	<.0001*		
PANAS positive	baseline	26.8±5.00	30.84±4.09	<0.0001*	-0.9(-1.11, -0.4)
	6 months	36.9±3.51	33.12±4.98	<0.0001*	
	p value (within group)	<.0001*	<.0001*		
PANAS negative	baseline	33.82±7.76	31.22±9.15	0.12	0.71(0.30, 1.11)
	6 months	21.48±5.09	26.48±8.46	<0.001*	
	p value (within group)	<.0001*	<.0001*		
six minute walk test	baseline	483.8±67.51	489.6±85.49	0.70	-0.99(-1.41, -0.58)
	6 months	619.3±83.70	530.2±94.29	<0.0001*	
	p value (within group)	<.0001*	<.0001*		
PSS	baseline	20.96±7.01	19.92±8.30	0.50	0.50(0.10, 0.90)
	6 months	15.3±3.36	18.16±7.27	0.01*	
	p value (within group)	<.0001*	<.0001*		
LVEF	baseline	34.14±5.57	34.92±6.01	0.50	-1.07(-1.49, -0.65)
	6 months	44.5±6.41	37.06±7.37	<0.0001*	
	p value (within group)	<.0001*	<.0001*		

DISCUSSION

In the present study, among patients undergoing Yoga, 10% were hypertensive, 16% had diabetes mellitus type 2 while 8% were suffering from both hypertensive and diabetes. In study by Nagarathna et al.^[11] in patients undergoing Yoga, 29.4% hypertensive, 15.5% had diabetes mellitus, 41% were both hypertensive and diabetes. (REACH Registry) Mehta et al emphasised the need to concentrate more on the secondary prevention after CABG and aggressively tried to attain the target goals in risk factor modification in order to prevent further cardiac events.^[12] There were total 48 patients (48%) with baseline FBS greater than 110 mg/dl (22 in Yoga the group and 30 in the control). There was significant decrease within both the groups at the end of 6 months. These results reflect the findings by Singh et al.^[13] Significant weight reduction was achieved by additive effect of Yoga in present study. Aldana et al.^[14,16] reported decrease in angina/weight loss /interventions /progression of coronary atherosclerosis. Similarly weight reduction was reported by Billings et al (2000).^[17] In present study, there is significant improvement in lipid profile components with addition of Yoga. However there is an overall shift towards less of an atherogenic state which might halt progression of asymptomatic stenosis or might reverse it as suggested by Billings JH et al.^[17] and Vyas et al

(2002).^[18] and Khatib M et al (2014).^[19] We found a decrease in inflammatory marker hsCRP with addition of Yoga to physiotherapy regimen similar to Pullen et al (2010).^[20,21] and Selman et al.^[22] We found improvement in stress related scales. Depression accounts for major adverse cardiac events, mortality, re-admission, and psychosocial dysfunction after CABG.^[23] Reid et al (2005).^[24] and Engblom et al.^[25] Another study observed significant reductions in both state and trait anxiety after 6 weeks of progressive muscular relaxation in anxious patients after CABG.^[26] Patients who listened to audiotape information containing information to improve post-operative outcomes had significantly increased physical activity with fewer symptoms of shoulder pain or back pain or anorexia, than the control group.^[27] The present study proves the relevance of complimentary effects of Yogic relaxation with the hypothesis that this would offer additional benefits of early recovery to conventional post-CABG rehabilitation. Yoga is a psychosomatic spiritual discipline with mind-body (psychological and physical) techniques which integrates breathing exercises (pranayama), physical poses (asanas), meditation (dhyana) which promotes health.^[28-30,31,32,33] Tuly et al reported incidence of anxiety and depression as 30 - 40% in CABG patients contributing to short- and long-term morbidity after the procedure.^[34] In present study patients showed significant improvement in 6-minute walk test both

within individual groups and also additive role of yoga was significantly found. Clinical trials have demonstrated supplemental effect of yoga over standard medical therapy in patients of heart failure in improving exercise tolerance.^[21] and cardiovascular endurance.^[22,35] Aldana et al.^[14] demonstrated improved exercise tolerance in patients randomised for yoga in one group and usual care in another. In fact, in present study we demonstrated that yoga based cardiac rehabilitation (YBCR) improved QOL over 6-month period significantly as add on therapy. In fact, it is noteworthy that a few interventional studies.^[27-29] found no improvement in QOL after 6 weeks to one year of interventions which pointed towards need for well-structured interventions. Keeping this in mind we designed this study very carefully regarding type, duration and frequency of interventions. Middel B et al stressed upon psychological distress as a strong predictor causing deteriorating Quality of Life parameters.^[36] LVEF as seen in 2D echocardiogram correlates well to invasive data. LVEF influences the immediate post-operative morbidity and late mortality after CABG. In our study, there was improvement in LVEF over a period of 6 months in YBCR+PBCR arm as well as in control arm. Cardiac rehabilitation post myocardial rehabilitation seems to have a favourable impact over left ventricular ejection fraction. Ornish et al.^[37,38] had similarly reported improvement in left ventricular regional wall motion during peak exercise in patients following lifestyle modification therapy within 3 months of therapy. Then we tried to answer a fundamental question whether patients with severe left ventricular dysfunction enjoy additive benefit over patients with moderate left ventricular dysfunction patients? Significant improvement was noted in patients with moderate and severe LV dysfunction individually in parameters such as LDL/HDL, WHO QOL BREF Physical Scores, WHO QOL BREF Psychological Scores, Δ PANAS Positive Effect Scores, PANAS Negative Effect scores, Six Minute Walk Test (distance covered). The subgroup analysis further demonstrated no significant additive benefit enjoyed by patients having severe LV dysfunction over patients with moderate LV dysfunction. Rather the former group experienced no significant benefit in decline of hsCRP levels or improvement in Perceived Stress Score over the latter group [Table 6, Table 7].

Table 6 Between group comparison for participants with LVEF \leq 30% (n = 28)

Clinical Outcome	YBCR + PBCR(n= 15)	PBCR(n = 13)	p-value(b/w group)
Δ LDL/HDL	-1.13 \pm 1.02	-0.43 \pm 0.51	0.03*
Δ hs-CRP	-0.80 \pm 0.53	-0.42 \pm 0.49	0.06
Δ WHO QOL BREF Physical	17.93 \pm 8.12	9.76 \pm 8.24	0.01*

Δ WHO QOL BREF Psychological	15.66 \pm 6.64	4.84 \pm 7.63	<0.01*
Δ PSS	-5.06 \pm 4.80	-2.38 \pm 2.78	0.08
Δ PANAS Positive Effect	10.06 \pm 5.10	2.76 \pm 4.69	< 0.01*
Δ PANAS Negative Effect	-13.73 \pm 5.00	-5.76 \pm 6.33	< 0.01*
Δ Six Minute Walk Test	125.33 \pm 62.77	49.23 \pm 45.90	<0.01*

*significant (p<.05), Δ = change (Final value after 6 months- Initial value at baseline)

Table 7 Between group comparison for participants with LVEF \leq 30% (n = 28)

Clinical Outcome	YBCR + PBCR(n= 35)	PBCR(n = 37)	p-value(between groups)
Δ LDL/HDL	-1.20 \pm 0.81	-0.45 \pm 0.67	<0.01*
Δ hs-CRP	-0.77 \pm 0.55	-0.17 \pm 0.28	<0.01*
Δ WHO QoL BREF Physical	13.17 \pm 7.89	5.24 \pm 6.45	<0.01*
Δ WHO QoL BREF Psychological	14.17 \pm 8.85	4.83 \pm 4.66	<0.01*
Δ PSS	-5.91 \pm 4.91	-1.54 \pm 3.14	<0.01*
Δ PANAS Positive Effect	10.11 \pm 5.48	2.10 \pm 2.15	<0.01*
Δ PANAS Negative Effect	-11.74 \pm 5.90	-4.37 \pm 5.52	<0.01*
Δ Six Minute Walk Test	139.85 \pm 63.94	37.56 \pm 46.98	<0.01*

*significant (p<.05), Δ = change (Final value after 6 months- Initial value at baseline)

CONCLUSION

We observed significant differences in YBCR group plus PBCR versus PBCR alone in terms of significant reduction in body weight, LDL, triglyceride, hs CRP, PANAS negative social scale score. There is significant increase YBCR+PBCR group versus PBCR alone in HDL, distance covered in six-minute walk test, WHO-QOL BREF scale score, PSS scores, PANAS positive Affect scores and increase in left ventricular ejection fraction. No significant difference between groups could be found in terms of BMI, waist hip ratio, total cholesterol, VLDL although there was improvement in BMI within individual groups. This subgroup analysis demonstrated no significant additive benefit enjoyed by patients having severe LV dysfunction over patients with moderate LV dysfunction. Rather the former group experienced no significant benefit in decline of hsCRP levels or improvement in Perceived Stress Score over the later group. Significant improvement was noted in patients with moderate and severe LV dysfunction individually in parameters such as LDL/HDL, WHO QOL BREF Physical Scores, WHO QOL BREF Psychological Scores, Δ PANAS Positive Effect Scores, PANAS Negative Effect scores, Six Minute Walk Test (distance covered). Yoga is safe for patients with

severe LV dysfunction provided patients are demonstrated the yoga practices with handouts, audiovisual tapes, and constant encouragement. Since this is a pilot study in terms of studying patients with severe left ventricular dysfunction undergoing Yoga as a means of rehabilitation, further studies with more number of patients with longer follow up are needed to further evaluate these findings.

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