International Research Journal of Multidisciplinary Scope (IRJMS), 2024; 5(4):702-710 IRJMS

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2024.v05i04.01258

A Randomized Controlled Clinical Study to Evaluate the Effect of Terminalia Arjuna (Add-On Medication) on Cardiac Function in Coronary Artery Disease

Vaishali Kuchewar*, Pankaj Yadav, Tanika Yadav

Department of Kayachikitsa, Mahatma Gandhi Ayurved College Hospital and Research Centre, Salod (Hirapur), Datta Meghe Institute of Higher Education and Research (Deemed to be University), Wardha, Maharashtra, India. *Corresponding Author's Email: vkuchewar@gmail.com

Abstract

Globally, coronary artery disease (CAD) is the foremost cause of death. Its frequency is also rising rapidly in underdeveloped nations. It remains the leading cause of morbidity and death despite tremendous advancements in diagnostics and intervention. Therefore, an integrated approach is required, along with the search for a drug having cardio protective and rejuvenating property. According to Ayurveda, Terminalia arjuna is a known hridya (Cardio protecting) herb. The purpose of this study was to investigate whether Terminalia arjuna improves cardiac function in CAD patients. This medication was administered as an adjunct to the medications that the cardiologist had prescribed. It is an experimental, parallel group study. Patients with coronary artery disease between the ages of 40 and 70 years were randomly assigned to both groups. In one group, typical conventional care was given, and the second group received Terminalia arjuna stem bark with conventional treatment. The course of treatment was ninety days. It is observed that most of the patients were of kapha-pittaj or pitta-kaphaj prakriti (specific body constitution). There were no significant changes in blood pressure and pulse rate and significant improvement in 6-minute walk test, ejection fraction, total cholesterol and triglycerides in comparison with standard group. From the observation, it can be concluded that Terminalia arjuna helps in improving cardiac function in patients of coronary artery disease.

Keywords: Coronary Artery Disease, Ejection Fraction, Hridya, Terminalia Arjuna, 6MWT.

Introduction

Coronary artery disease (CAD) has been identified as the foremost cause of death worldwide (1, 2). "According to a report of World Health Organization (WHO) in 2005, it caused 17.5 million (30%) of the 58 million deaths that occurred worldwide" (3). In India, CAD has increased significantly over the past two decades. Its prevalence in urban and rural population is between 7% - 13% (4-6) and 2% - 7% (7,8) respectively. In 2020, the global burden of CAD in men and women were 14.4 million and 7.7 million respectively (9). Poorly managed cardiovascular disease (CVD) may result in serious long-term disability also. One of the main objectives of treating patients with stable ischemic heart disease (SIHD) is to minimize death, retain quality of life, and minimize hospital costs. In view of the stated objective, a search continues to focus on for non-invasive alternative treatment approaches. Numerous ancient Indian medical writings, such as the Charak Samhita, Sushrut Samhita, and Ashtang Hidaya, mentioned Terminalia arjuna. Vagbhat has specifically mentioned its stem bark for cardiac ailments (10). Stem bark is reported to have blood pressure-lowering, antioxidant, hypolipidemic, anti-ischemic, and antiplatelet characteristics in a number of studies (11). Studies are carried out to evaluate Terminalia arjuna's effectiveness in treating various cardiovascular conditions (12-17). Globally, coronary artery disease is the leading cause of death, and its prevalence is growing significantly. Even with the progress of cardiovascular therapies, CAD remains the primary cause of morbidity and mortality. All of the currently recommended lifetime medications lower blood pressure inhibits platelets, and lower cholesterol, but none of them have any cardio-protective effects. Therefore, collaborated treatment is required. In particular, Terminalia arjuna is referred to as Hridya (Cardio protecting). Therefore, the purpose of this study

(Received 8th June 2024; Accepted 17th October 2024; Published 30th October 2024)

was to assess Terminalia arjuna's beneficial effects on cardiac function in patients with CAD. This medication was administered in addition to the medications prescribed by the cardiologist. The study is an exploratory parallel group trial with a 1:1 patient allocation ratio. The study group received conventional treatment plus an extract from Terminalia arjuna, while the comparative group received normal treatment regimen. The study's goal was to assess Terminalia arjuna's impact on heart function using the six-minute walk test (6MWT) and ejection fraction measurements.

Methodology

The study was conducted in a teaching hospital. The Institutional Ethics Committee gave its approval to this study (DMIMS (DU/IEC/Aug-2019/8309). The CTRI registration is done before commencement of study (REF/2019/11/029029) The informed consent form was signed by each participant

Inclusion Criteria: The age group of Participant was 40-70 years of either sex. The diagnosis of CAD was done on one of the following investigations; ECG, Transthoracic echocardiography, Treadmill exercise test (TMT). Stable patients of CAD were enrolled for study. Exclusion Criteria: Participants having following ailments were not enrolled in study

- Patients of coronary bypass surgery, or coronary stenting of the period < 1 months
- Patients of Arrhythmia
- Patients of severe heart failure
- Patients with any type of serious infection.
- Patients with Renal failure or Chronic kidney disease(CKD)
- Patients with Portal hypertension
- Critically ill patient
- Patient with Type I Diabetes mellitus or uncontrolled Type II Diabetes mellitus.
- Patients with chronic obstructive pulmonary disease

It was a pilot study, hence the numbers of patients were recruited in trial and standard group were 11 &15 respectively. The sequential numbered method was adopted for randomization. The assessor was blinded about inclusion of patient in either group. The control group received the standard conventional treatment that the cardiologist had given, which included antihypertensive, antilipidemic, and antiplatelet medications. The interventional group received 500 mg tablet of aqueous extract of Arjun bark (Terminalia arjuna) with standard conventional treatment. The treatment was given for 90 days. It was suggested to consume the trial medication and standard treatment one hour apart. The patient was given a pocket diary to record their medication intake regimen and to note any negative side effects. In case of an emergency, the lead investigator's phone number was supplied. The patient was instructed to bring the medication container to track medication adherence. Relevant concurrent care: The patients in both groups were instructed for 30-minute walk, every morning and to adhere to a general food plan that was low in fat and salt, and high fibre. It was recorded in the case proforma to prevent confounding factors. At the completion of the 90-day course of treatment, the primary outcomes involve assessing the effect of Terminalia arjuna on heart function by determining the ejection fraction using Transthoracic echocardiography and 6 minute walk test (6MWT)(Figure 1).

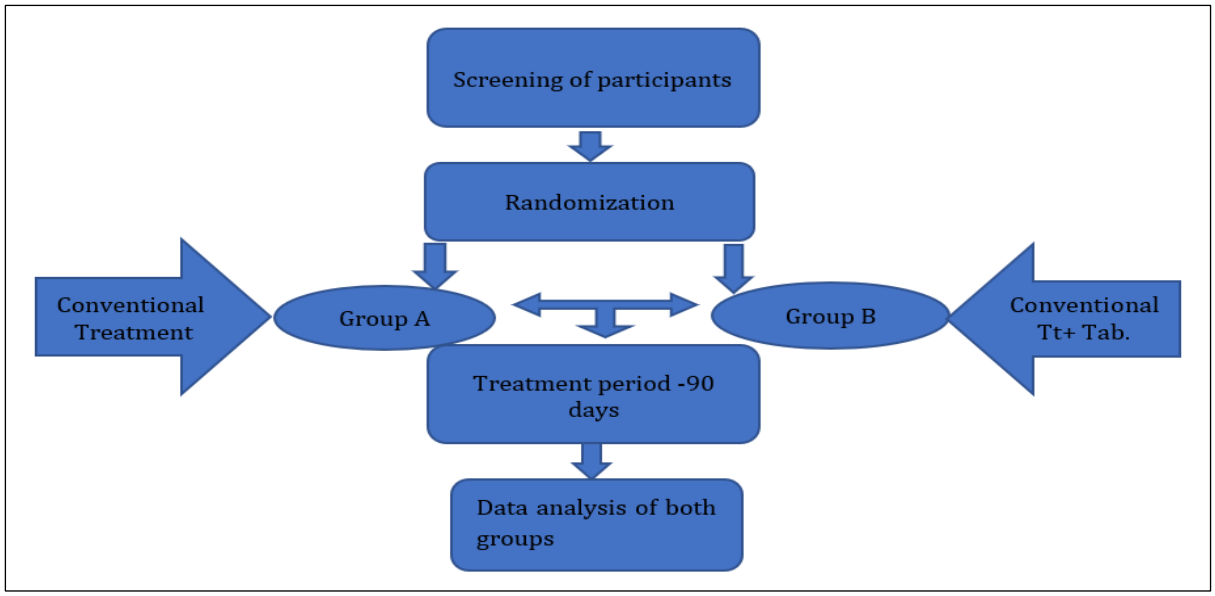

Figure1: Schematic Diagram of Study Methodology.

At the time of enrollment, demographic information (age, sex, nationality), as well as any prior serious or mild illnesses, were noted. The results of the baseline studies and the investigations conducted following the course of treatment, or after 90 days, were acquired. During treatment, there was a follow-up every two weeks. Their diary was examined for drug adherence and any adverse events that may have occurred during this time. To remind them to take their medication, participants received daily phone calls during the first week and weekly calls during the subsequent weeks.

Results

SPSS software (version 22) was used for statistical analysis. The data was analyzed using the paired t-test (Wilcoxon sign rank) and the unpaired t-test (Wilcoxon Rank-sum). It was observed in Figure 2 that in trial group, 63.64% patients were in the age group of years 45-55 and in standard group, 53.3% patients were in the age group of years 55-65. Figure 3 shows Out of 11 subjects in trial group and 15 in standard group, 45% and 73.3% subjects were male and 54.5% and 26.7% were female in trial and standard group respectively. In both the groups, the predominant prakriti was kapha-pittaj and pitta-kaphaj (Figure4).

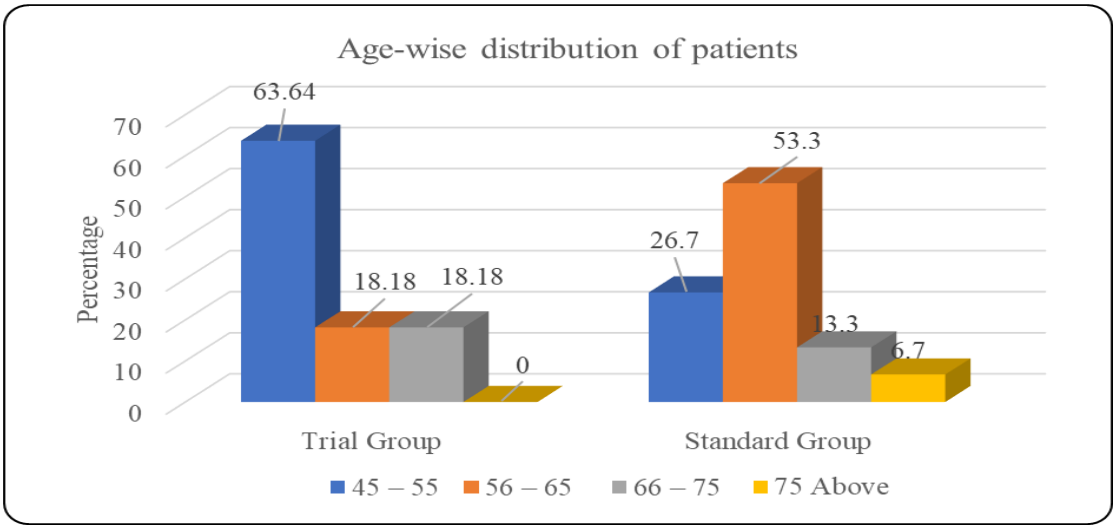

Figure 2: Age-Wise Distribution of Patients

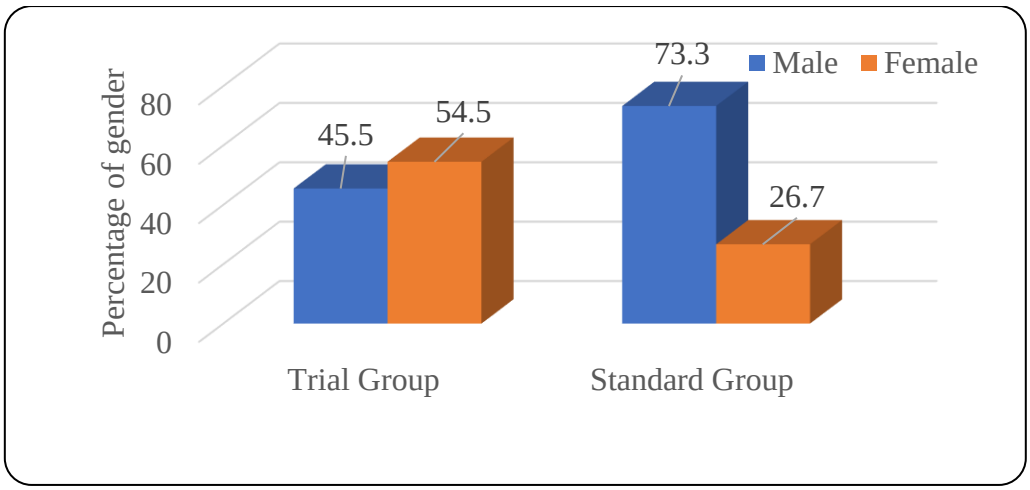

Figure 3: Gender-Wise Distribution of Patients

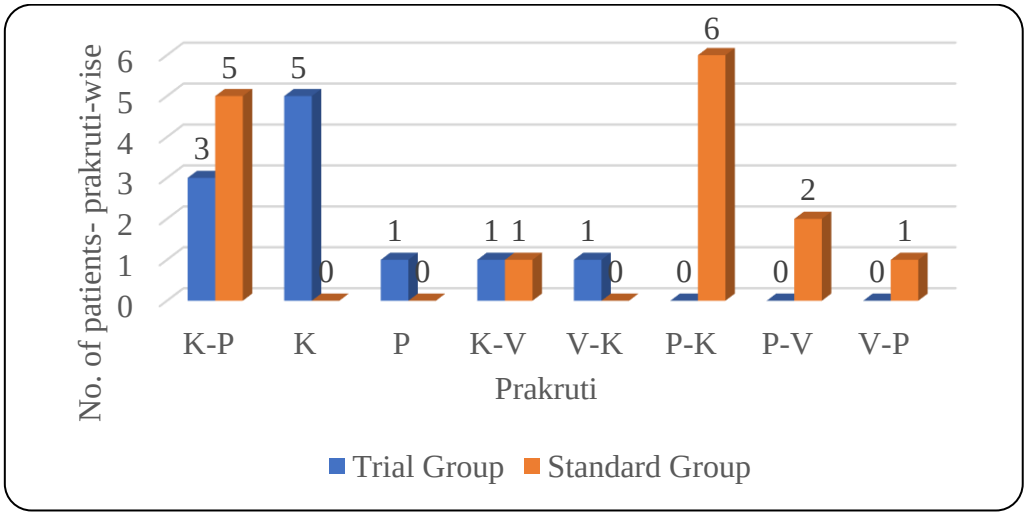

Figure 4: Prakruti-Wise Distribution of Patients

Table 1: Comparison of Mean Blood Pressure (Systolic) of Patients

Blood Pressure (Systolic)		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	132.73	13.48	4.07	5.45	4.11%	1.399	0.192
	90 Day	127.27	4.67	1.41				
Standard Group	0 Day	125.33	10.60	2.74	0.667	0.53%	0.269	0.792
	90 Day	124.67	5.16	1.33				

Table 2: Comparison of Mean Blood Pressure (Diastolic) of Patients

Blood Pressure (Diastolic)		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	82.73	6.47	1.95	0.00	0.0%	0.00	1.00
	90 Day	82.73	4.67	1.41				
Standard Group	0 Day	80.00	6.55	1.69	-1.333	1.66%	-0.807	0.433
	90 Day	81.33	3.52	0.91				

Table 1 and Table 2 shows, in trial group, mean systolic and diastolic blood pressure before treatment was 132.73+/- 13.48 and 82.73 +/- 6.47 which was reduced to 127.27+/- 4.67 and 82.73 +/- 4.67 respectively after treatment that was not statistically significant. In standard group, mean systolic & diastolic blood pressure before treatment was 125.33+/- 10.60 and 80.00 +/-6.55 which were reduced to 124.67+/- 5.16 and 81.33+/-3.52 respectively after treatment that was also not statistically significant. Table 3 shows, In trial group, mean pulse rate before treatment was 75.91+/- 6.20 which was reduced to 74.27+/- 3.17 after treatment which was not statistically significant. In standard group, mean pulse rate before treatment was 75.27+/- 5.73 which were reduced to 75.60+/- 3.66 after treatment that was also not statistically significant.

Table 3: Comparison of Mean Pulse Rate of Patients

Pulse Rate		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	75.91	6.20	1.87	1.64	2.16%	0.997	0.342
	90 Day	74.27	3.17	0.95				
Standard Group	0 Day	75.27	5.73	1.48	-0.333	0.44%	-0.388	0.704
	90 Day	75.60	3.66	0.95				

Table 4: Comparison of Mean 6 Minute Walk Test of Patients

6 Minute Walk Test		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	464.09	178.03	53.68	-53.18	11.46%	-7.134	0.001
	90 Day	517.27	188.15	56.73				
Standard Group	0 Day	446.67	77.06	19.90	-30.667	6.86%	-4.145	0.001
	90 Day	477.33	70.76	18.27				

Table 4 shows, in trial group, mean 6 Minute Walk Test before treatment was 464.09+/- 178.03 which was improved to 517.27+/- 188.15after treatment. In standard group, it was 446.67+/- 77.06 which were improved to 477.33+/- 70.76 after treatment. In trial group, there was 11.46% improvement in 6 Minute Walk Test whereas only 6.86% improvement was observed in standard group. In Table 5, it was observed that mean value of HsCRP on 0 day was 2.64 whereas on 90th day it was 1.53 in trial group. In standard group, mean value of HsCRP on 0 day was 1.23 whereas on 90th day, it was 1.04. There was 42.04% change HsCRP in trial group patients whereas only 15.44% change was observed in standard group.

Table 5: Comparison of Mean HsCRP (high-sensitivity C-reactive protein) of Patients

HsCRP		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	2.64	2.37	0.71	1.11	42.04%	2.391	0.038
	90 Day	1.53	0.90	0.27				
Standard Group	0 Day	1.23	0.10	0.03	0.184	15.44%	2.344	0.034
	90 Day	1.04	0.34	0.09				

Table 6: Comparison of Mean Ejection fraction of Patients

2D Echo		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	57.63	4.50	1.35	-3.27	5.67%	-3.500	0.006
	90 Day	60.90	3.01	0.90				
Standard Group	0 Day	55.60	3.92	1.01	-1.667	3.00%	-3.371	0.005
	90 Day	57.27	2.63	0.68				

In Table 6, 2D Echo-cardiography, mean ejection fraction on 0 day was 57.63% whereas on 90 day it was 60.90 in trial group. From the paired t-test statistic it was found that there is significant difference between ejection fraction on 0 day and 90th day as t statistic = -3.500 and p = 0.006 at 95% level of significance. In standard group, mean ejection fraction on 0 day was 55.60 whereas on 90th day, it was 57.27 in standard group. From the paired t-test statistic, it was found that there is significant difference as t statistic = -3.371 and p = 0.005 at 95% level of significance. Table 7 shows, in trial group, mean total cholesterol before treatment was 213.73+/- 37.22which was reduced to 184.18+/- 21.48 after treatment which was statistically significant. In standard group, mean total cholesterol before treatment was 193.47+/- 23.61 which were reduced to 190.27+/- 23.35 after treatment. Table 8 shows, In trial group, mean triglycerides before treatment was 205.78+/- 50.15 which was reduced to 179.18+/- 43.59 after treatment which was statistically significant. In standard group, mean triglyceride before treatment was 146.20+/- 44.43 which were reduced to 143.47+/- 40.50 after treatment which was statistically insignificant.

Table 7: Comparison of Mean Lipid Profile – Total cholesterol (TC) of Patients

Lipid Profile - TC		**Mean**	**Std. Deviation**	**Std. Error Mean**	**Mean Difference**	**% Change**	**Paired t Test**	**P Value**
Trial Group	0 Day	213.73	37.22	11.22	29.55	13.83%	3.956	0.003
	90 Day	184.18	21.48	6.48				
Standard Group	0 Day	193.47	23.61	6.10	3.200	1.65%	3.361	0.005
	90 Day	190.27	23.35	6.03				

Table 8: Comparison of Mean TG (Triglycerides) of patients

Lipid Profile - TG		**Mean**	**Std. Deviation**	**Std. Error Mean**	**Mean Difference**	**% Change**	**Paired t Test**	**P Value**
Trial Group	0 Day	205.78	50.15	15.12	26.60	12.93%	4.052	0.002
	90 Day	179.18	43.59	13.14				
Standard Group	0 Day	146.20	44.43	11.47	2.733	1.87%	1.312	0.211
	90 Day	143.47	40.50	10.46				

Table 9: Comparison of Mean HDL (high density lipoprotein) of patients

Lipid Profile - HDL		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	43.36	5.07	1.53	-2.45	5.67%	-3.061	0.012
	90 Day	45.82	3.43	1.03				
Standard Group	0 Day	47.60	4.32	1.12	-0.467	0.98%	-1.284	0.220
	90 Day	48.07	3.58	0.92				

Table 10: Comparison of Mean LDL (low density lipoprotein) of patients

Lipid Profile - LDL		Mean	Std. Deviation	Std. Error Mean	Mean Difference	% Change	Paired t Test	P Value
Trial Group	0 Day	137.48	26.37	7.95	13.03	9.47%	4.261	0.002
	90 Day	124.45	21.66	6.53				
Standard Group	0 Day	86.87	30.16	7.79	4.00	4.60%	2.125	0.052
	90 Day	82.87	24.89	6.43				

Table 9 shows, in trial group, mean high density lipoprotein before treatment was 43.36+/- 5.07 which were improved as 45.82+/- 3.43 after treatment which was statistically significant. In standard group, mean high density lipoprotein before treatment was 47.60+/- 4.32 which were

improved as 48.07+/- 3.58 after treatment which was statistically insignificant. Table 10 shows, in trial group, mean low density lipoprotein before treatment was 137.48+/- 26.37which was reduced to 124.45+/- 21.66 after treatment which was statistically significant. In standard group, mean low density lipoprotein before treatment was 86.87+/- 30.16 which were reduced to 82.87+/- 24.89 after treatment.

Discussion

This study was conducted to compare the therapeutic efficacy of Arjun ghana(as an adjuvant to standard treatment)and standard conventional treatment on Cardiac function in patients of Coronary artery disease. According to demographic statistics, the coronary artery disease was commonly found in between the age group of 45 and 65 yrs. The number of females is more in the age group of 56-65, whereas males are predominantly in age group of 45-55. While the causes in males could be stress, addiction, poor eating habits, and a sedentary lifestyle. Women have a low incidence of CAD events before to menopause. It might be due to endogenous estrogen which delays the manifestation of atherosclerotic disease. Estrogen has significant role in regulation of inflammatory markers, coagulant system and lipids. It also helps in vasodilatation through the α and β receptors in the vessel wall (18). The transition to menopause is linked to a worsening CAD risk profile (19). The majority of patients were having prakriti of kaphaj predominance. As per Ayurveda texts, Kapha is responsible for Santarpanjanya vyadhi(diseases caused due to excessive nutrition) .There was no significant change in pulse rate and blood pressure (systolic and diastolic) in both the groups. There was improvement in 6 Minute Walk Test in both the groups, but the percentage of improvement is more in experimental group. The percentage of change in hsCRP in trial group is significant than standard group. The ejection fraction was improved in trial group in comparison with standard group; there was significant reduction in triglyceride in trial group as compared to standard group. Rest of the parameters of lipid profile had no significant change. Terminalia arjuna may have following probable mode of action for improving cardiac function.

Increase in Coronary Flow

Arjuna bark stem has chronotropic, inotropic, and diuretic effects. It has been shown that the aqueous extract increases coronary flow in the Langendorff's rabbit heart preparation. Recent experimental research has confirmed the previous findings, showing that arjuna aqueous extract improved the contraction force of cardiac muscle in isolated perfused rabbit heart, hypodynamic frog heart in situ, and frog heart in situ. Bradycardia was produced and the coronary flow in the isolated perfused rabbit heart was enhanced. It is thought that the plant's high Ca++ concentration acts as a mediator for the inotropic effect (20, 21).

Reversal of Cardiac Injury Enzyme & Improved Mitochondrial Uptake

Arjuna has properties of restoring myocardial integrity and cardiac function. It was observed that the increased levels of serum glutamate oxaloacetate transaminase, creatine phosphokinase, γ-glutamyl transpeptidase and glutamate pyruvate transaminase were reversed by Terminalia arjuna in myocardial necrosis. Furthermore, there was a significant protection against the decreased levels of γ-glutamyl transpeptidase, succinate dehydrogenase, glycogen, and mitochondrial oxygen uptake in the heart (22).

Cardiac Protection Against Oxidative Stress

Terminalia arjuna enhanced the cardiac intracellular antioxidant activity and cardio-protective action in various antioxidant enzyme activities, cellular metabolite levels, lipid peroxidation end products, glutathione levels, and protein carbonyl contents in cardiac tissues. It increases the cardiac antioxidant enzymes, reduction in lipid peroxidation and decrease in serum CKMB levels. An electron microscopic study shows reduction in Z-band disarray, mitochondrial swelling, lipid inclusions and focal dilatation of smooth endoplasmic reticulum (SER) after intake of Terminalia arjuna. The study conducted on Terminalia arjuna ethanol extract (TAEE) in protecting murine hearts from sodium fluoride (NaF)-induced oxidative stress demonstrates TAEE shields murine hearts from oxidative stress caused by NaF, most likely because of its antioxidant qualities (23). TAEE shields murine hearts from oxidative stress caused by NaF, most likely because of its antioxidant qualities. The study conducted on butanolic fraction of Terminalia arjuna bark

shows protective potential effects against Dox-induced cardiotoxicity (24).

Anti-Inflammatory Activity of Bark Extract Corelated with Reduced Myocardial Injury

Terminalia arjuna bark extract has impact on reflex bradycardia. Arjuna's cardioprotective effects were similar to those of fluvastatin. The heart is significantly protected against catecholamine-induced cardiac heart failure (CHF) by arjuna bark extract, which may be achieved by preserving endogenous antioxidant enzyme activities and reducing LPO and cytokine levels (25). The study conducted by F khaliq *et al.* suggest that T. arjuna bark extract may have the effect of improving the altered baroreflex sensitivity in diabetic rats by lowering cytokine levels and preserving endogenous antioxidant enzyme activities (26).

Reduction in TC, TG & Increase in HDL

Terminalia arjuna lowers lipid levels by restricting the production of cholesterol in the liver, increasing the excretion of bile acids in the feces, activating the enzyme plasma lecithin: cholesterol acyltransferase, and stimulating the breakdown of low-density lipoprotein through receptor-mediated catabolism. The study conducted on rats fed cholesterol and triton, the bark powder of Terminalia arjuna was found to lower lipid levels and protein levels of β-lipoproteins, resulting in an increase in the level of high-density lipoprotein-cholesterol. It modifies lipolytic activities in liver, heart, plasma and adipose tissues of hyperlipaemic rats (27). Sharma *et al*.'s subsequent study confirmed arjuna's hypolipidemic and antioxidant properties. The hypolipidemic action is believed to be mediated by inhibition of HMG-CoA reductase, down-regulation of lipogenic enzymes, and increased hepatic clearance of cholesterol (28).

Conclusion

With the above observations, it can be concluded that Terminalia Arjuna promotes to improve cardiac function & to maintain lipids which is a contributing factor in coronary artery disease.

Abbreviation

Nil.

Acknowledgement

The authors would like to acknowledge Department of Research and Development for providing intramural fund for the study.

Author contributions

Vaishali Kuchewar – study conduction, Pankaj Yadav- study supervision and writing, Tanika Yadav- writing

Conflict of Interest

The authors declare no conflict of interest.

Ethics Approval

The ethics committee approval was taken before commencement of study.

Funding

Intramural funding was provided by Department of Research and Development of DMIHER (Deemed to be University).

References

1. Murray CJL, Lopez AD. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. The Lancet. 1997;349(9063):1436–1442.
2. Murray CJL, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. The Lancet. 1997;349(9061):1269–1276.
3. Alfredo M, Thomas A. The WHO report "Preventing chronic diseases: a vital investment" and us. Soz Praventivmed. 2006;51(2):74.
4. Mohan V, Deepa R, Rani SS. Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India. J Am Coll Cardiol. 2001; 38:682–687.
5. Gupta R, Gupta VP, Sarna M. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. Indian Heart J. 2002; 54:59–66.
6. Kamili MA, Dar IH, Ali G. Prevalence of coronary heart disease in Kashmiris. Indian Heart J. 2007; 61:44–49.
7. Gupta AK, Bharadwaj A, Ashotra S. Feasibility and training of multipurpose workers in detection, prevention and control of coronary artery disease in apple-belt of Shimla hills. South Asian J Prev Cardiol. 2002; 6:17–22.
8. Kumar R, Singh MC, Ahlawat SK. Urbanization and coronary heart disease: a study of urban–rural differences in northern India. Indian Heart J. 2006; 58:126–130.
9. Krishnan M. Coronary heart disease and risk factors in India e On the brink of an epidemic? Indian Heart Journal. 2012; 64(4):364-367.
10. Tripathi B. editor, Ashtanga Hridaya.,. Nirmala commentary. Delhi: Chaukhamba Sanskrit Pratishthan; 2022. Chikitsa Sthana, chapter 15, verse 74; 754.

11. Maulik SK, Talwar KK. Therapeutic potential of Terminalia arjuna in cardiovascular disorders. Am J Cardiovasc Drugs. 2012; 12:157–63.
12. Bhatia J, Bhattacharya SK, Mahajan P, Dwivedi S. Effect of Terminalia arjuna on coronary flow–an experimental study. Indian J Pharmacol. 1998; 30:118.
13. Jain V, Poonia A, Agarwal RP, Panwar RB, Kochar DK, Mishra SN. Effect of Terminalia arjuna in patients of angina pectoris (A clinical trial) Indian Med Gaz. 1992; 36: 56–9.
14. Dwivedi S, Agarwal MP. Antianginal and cardioprotective effects of Terminaliaarjuna, an indigenous drug, in coronary artery disease. J Assoc Physicians India. 1994; 42:287–9.
15. Dwivedi S, Jauhari R. Beneficial effects of Terminalia arjuna in coronary artery disease. Indian Heart J. 1997;49: 507–10.
16. Kumar PU, Adhikari P, Pereira P, Bhat P. Safety and efficacy of Hartoneinstable angina pectoris–an open comparative trial. J Assoc Physicians India. 1999; 47:685–9.
17. Bharani A, Ganguli A, Mathur LK, Jamra Y, Raman PG. Efficacy of Terminaliaarjuna in chronic stable angina: A double-blind, placebo-controlled, crossover study comparing Terminalia arjuna with isosorbidemononitrate. Indian Heart J. 2002; 54:170–5.
18. Sutton-Tyrell K, Lassila HC, Meilahn E, Bunker C, Matthews KA, Kuller LH. Carotid atherosclerosis in premenopausal and postmenopausal women and its association with risk factors measured after menopause. Stroke. 1998; 29:1116-21.
19. Matthews KA, Meilahn EN, Kuller LH, Kelsey SF, Caggiula AW, Wing RR. Menopause and risk factors for coronary heart disease. N Engl J Med. 1989; 321:641-6.
20. Dwivedi S, Jauhari R, Beneficial effects of Terminalia arjuna in coronary artery disease.Indian Heart J.1997;49(5):507-10.
21. Dwivedi S, Chansouria JPN, Somani PN, Udupa KN. Influence of certain indigenous drugs on the PGE like activity in the ischaemic rabbit aorta. Indian Drugs. 1987; 2: 378–382.
22. Tandon S, Rastogi R, Kapoor NK. Protection by abana, a herbomineral preparation, against myocardial necrosis in rats induced by isoproterenol. Phytother Res. 1995; 9: 263–266.
23. Sinha M, Manna P, Sil PC. Terminalia arjuna protects mouse hearts against sodium fluoride-induced oxidative stress. J Med Food. 2008; 4: 733–740.
24. Singh G, Singh AT, Abraham A, Bhat B, Mukherjee A, Verma R, et al. Protective effects of Terminalia arjuna against Doxorubicin-induced cardiotoxicity. J Ethnopharmacol. 2008; 117: 123–129.
25. Parveen A, Babbar R, Agarwal S, Kotwani A, Fahim M. Mechanistic clues in the cardioprotective effect of Terminalia arjuna bark extract in isoproterenol-induced chronic heart failure in rats. CardiovascToxicol. 2011; 11:48–57.
26. Khaliq F, Parveen A, Singh S, Hussain ME, Fahim M. Terminalia arjuna Improves Cardiovascular Autonomic Neuropathy in Streptozotocin-Induced Diabetic Rats. Cardiovasc Toxicol. 2013; 13: 68–76.
27. Khanna AK, Chander C, Kapoor NK. Terminalia arjuna: An Ayurvedic cardiotonic regulates lipid metabolism in hyperlipidemic rats. Phytother Res. 1996; 10: 663–665.
28. Sharma S, Sharma D, Agarwal N. Diminishing effect of arjuna tree (Terminalia arjuna) bark on the lipid and oxidative stress status of high fat high cholesterol fed rats and development of certain dietary recipes containing the tree bark for human consumption. Research in Pharmacy. 2012; 2(4): 22-30.