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**ORGINAL ARTICLE**

# Additive Effect of L-Carnitine Supplementation in Improving Systolic and Diastolic Functions in Patients with Dilated Cardiomyopathy

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## ABSTRACT

**Background:** L-Carnitine may protect cardiac muscle against oxidative stress, hypoxia and ischemia. The aim of this study was to assess the effect of L-Carnitine in improving systolic and diastolic function in patients with dilated cardiomyopathy.

**Methods:** We studied 160 patients who were admitted to Critical Care Department, Zagazig University diagnosed as dilated cardiomyopathy. The patients were classified into 2 groups:

Group I: Study Group: Includes 80 patients who received conventional anti failure measures plus L-Carnitine. L-Carnitine was given in a dose of 3gm/d divided in 3 doses, 1 gm at principal meals for up to 6 months. Group I subdivided into responders and non-responders. Group II: Placebo Group: Includes 80 patients who received conventional anti failure measures only.

Serum carnitine and echocardiographic parameters as left ventricular ejection fraction (EF), global longitudinal strain (GLS) by speckle tracking echocardiography and E/E′ using tissue Doppler imaging, were measured before the start of therapy, at 2 and 6 months later.

**Results**: Comparing the study versus placebo groups, there was statistically significant increase in EF in group I at 2 months (39.3±8% vs 33.52±4.8%, p: 0.001) and after 6 months (40.33±8% vs 34.5±4.8%, p: 0.001) as compared to group II respectively. Regarding GLS (- %), group I exhibited significant improvement in GLS at 2 months as compared to group II (16.5±2.9 vs 7.7±2.8, p: 0.001) which continued after 6 months (18.8±3.6vs 8.2±1.5, p: 0.001) respectively. Regarding E/E′ ratio, group I exhibited significant improvement in diastolic function at 2 and 6 months as compared to group II (p: 0.001) which continued after 6 months. There was no significant increase in levels of serum L carnitine in group I after 2 months (22.4±6.3 vs 19.4±2.5, p: 0.05) but there was significant increase in serum carnitine level after 6 months (35.8±10.1 vs 22.5±3.1, p: 0.01) as compared to group II. There was statistically positive significant correlation between EF and L-Carnitine (r= 0.6, p=0.001).

**Conclusion**: As a metabolic supplement the early administration of L-Carnitine plus conventional anti failure measures to patients with cardiomyopathy provides a significant improvement as regards clinical signs of heart failure and echocardiographic parameters namely EF, GLS and E/E′ with consequent improvement in quality of life for these patients.

**Keywords**: L Carnitine; Systolic; Diastolic; Dilated; Cardiomyopathy.

## INTRODUCTION

The myocardium's primary source of energy comes from the mitochondrial oxidation of long chain fatty acids. Carnitine, a low molecular weight amino-acid derivative, is important for the transport of long chain fatty acids across the mitochondrial membrane to beta oxidation site. These fatty acids are the precursor of energy for the heart [1]. Carnitine has two purposes. Carnitine reacts with long-chain fatty acids first through the enzyme carnitine palmitoyl transferase (CPT-1) to produce long-chain acyl carnitine esters. The second is to pass the inner mitochondrial membrane with free carnitine and long chain acyl carnitine. Inside the mitochondrial matrix, the long chain acyl carnitine is converted

again to free carnitine and long chain fatty acids via CPT-II. Carnitine plays this great role as fatty acid oxidation supplies the heart with nearly 60% of its total energy [2]. Another role of carnitine is to help in the removal of excess acyl groups from mitochondria [3]. The mitochondrial enzyme carnitine acetyl transferase uses carnitine to control the oxidation of glucose [4]. Carnitine regulates the activity of pyruvate dehydrogenase by reducing fluctuations in the ratio of acyl co-a to free co-a. It is suggested that adequate carnitine levels are necessary for normal energy metabolism and heart systolic function, several case reports have demonstrated that some patients with carnitine deficiency may develop cardiomyopathy [5], but this is not generally true. Mostly, it has to do with how heart function was evaluated and how severe the carnitine shortage was. Change in plasma levels of carnitine has been shown in patients with cardiac arrhythmias and congestive heart failure [7]. The cardiac tissue is severely affected by carnitine deficiency or altered metabolism [8]. Clinical studies in patients with advanced heart failure such as dilated cardiomyopathy, acute myocarditis and rheumatic valvular disease have revealed low carnitine levels in the left ventricle [9]. The aim of this study is to assess the efficacy of L-Carnitine supplementation as an adjunctive therapy on systolic and diastolic functions in patients with dilated cardiomyopathy.

## METHODS

This study involved 160 patients (112 male and 48 female) who were admitted to the critical care unit at Zagazig University diagnosed as dilated cardiomyopathy during the period from February 2019 to February 2022 equally divided into 2 groups of eighty.

Group I: (Study group) patients treated with conventional anti-failure therapy with additional L Carnitine orally administered, Group II: (Placebo group) patients treated with conventional anti-failure therapy. Conventional anti-failure therapy included: ACEI, BB, Eplerenone , but only 15% of the studied patients were on SGLT2 inhibitors.

**Informed consent and ethics committee/IRB approval:**

An informed consent has been obtained from patients.The Institutional Review Board (IRB), Zagazig University's School of Medicine, gave its clearance.Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

**Inclusion criteria:** Patients with dilated cardiomyopathy, LV ejection fraction less than 40%. **All patients were subjected to:** History taking, full clinical assessment including clinical examination, CXR, standard 12-lead ECG and 2D-Echocardiography with special emphasis on systolic function, EF was assessed by modified Simpson method, also global longitudinal strain was assessed using speckle tracking echocardiography and diastolic function, E/E′ ratio was assessed using tissue Doppler imaging.

Serum carnitine level before the start of therapy. L-Carnitine was administered orally at daily dose of three grams that was divided into 3 doses, 1gm during principle meals. Evaluation was done by echocardiographic parameters and serum carnitine done at baseline, 2 and 6 months after.

It was also agreed to define the following:Outcome means Improvement of patient condition as regard clinical data and echocardiographic parameters (EF, GLS and E/E′ ratio). Responders include patients who show improved outcome (Clinical HF NHYA status, echocardiographic parameters: EF, GLS and E/E′ ratio). Non-responders include patients who remain the same. Mild heart failure include grade II NYHA class. Severe heart failure includes grade III, IV NYHA class.

Principle of the test: Acetyl coenzyme A (Acetyl COA) transforms L-carnitine into acetyl carnitine in the presence of the enzyme carnitine acetyl transferase (CAT). In the presence of adenosine triphosphate (ATP) and acetate, the resultant coenzyme A (COA) is acetylated back to acetyl COA by the enzyme acetyl COA synthetase (ACS). Adenosine- 5'- monophosphate (AMP) and inorganic pyrophosphate are produced because of this (PPi). Adenosine diphosphate is produced in twofold greater amounts by AMP in the presence of TP, assisted by myokinase (MK) (ADP). In the subsequent reaction with phosphoenol pyruvate (PEP) and pyruvate kinase, this is transformed (PK). In the presence of lactate dehydrogenase, reduced nicotinamide adenine dinucleotide (NADH) converts the pyruvate produced into L-lactate (LDH). When the reaction is complete, half as much L-Carnitine is consumed as NADH. The variable to be measured is NADH. Its absorption at 334 (Hg), 340, or 365 (Hg) nm is used to calculate it.

**Reference values:** In serum: 6.9mg/L or 43 mmol/L.

**Preparation of the samples:** Serum sampling by collecting venous blood into a plain test tube to

collect serum. Prepare serum in the usual way. Serum has to be deproteinized. The deproteinized serum is stable at 2-8° C for 5 days, then deproteinization (Table 1):

## STATISTICAL ANALYSIS

Data was analyzed using SPSS (Statistical Package for Social Sciences) version 24. Qualitative data was presented as number and percent. Comparison between groups was done by Chi-Square test. Quantitative data was tested for normality by Kolmogrov-Smirnov test. Normally distributed data was presented as mean ± SD. Student t-test was used to compare between two groups. Multivariate analysis using forward stepwise multiple linear regression was used to determine the independent predictor of CAD among patients with LBBB. $p<0.05$ was considered to be statistically significant.

## RESULTS

**I- Clinical characteristics and risk factors (Table 2):**

Both groups are equally matched for age and sex. In the group I, the mean age was 45.6±10 years whereas in group II it was 55.4±7 years. (p: NS). In group I, there were 42 males (52.5%) and 38 females (47.5%), whereas in group II, there were 48 males (60%) and 32 females (40%) (p: NS). Other than obesity, there was no statistically significant difference in the risk factors between the two groups. Additionally, there was no statistically significant difference in baseline NYHA class between the two groups. In group I, there were 22 patients (27.5%) had mild heart failure (class II) vs 28 patients (35%) in group II and 58 patients (72.5%) with class III, IV in group I vs 52 patients (65%) in group II, p: NS.

**II- Baseline serum L carnitine for both groups (Table 2):**

In both groups the baseline serum level of L carnitine is below the normal range but no statistically significant difference in baseline serum L carnitine between the study (14.27±6.8 mmol/L) and placebo groups (16.5±3.6 mmol/L), p: 0.07.

**III- Clinical outcome of the study group (group I) as shown in (Table 3):**

_ In group I, there were 80 patients; 78 of them continued the research, and two of them died from severe heart failure.

_ After 2 months, we subdivided the group (I) according to the clinical outcome and quality of life into:

- Responders group (Group A): Includes 56 patients (72%) who showed improved outcome (EF, GLS and E/E′ ratio) and good quality of life (assessed by HF NHYA status).
- Non responders group (Group B): Includes 22 patients (28%) who remained the same without improvement in clinical outcome.

_ After 6 months: Due to bad patient compliance, 48 patients only continue up to 6 months. 36 patients out of them showed improved outcome.

**IV- Echocardiographic parameters of responders and non responders groups (Table 4):**

- EF: After two months, there was a statistically significant difference in the EF between the responders (41%±6.4) and the non-responders (35% ±10.3) (p = 0.03), whereas after six months, the EF was still higher in the responders group (41.2% ±7.3) as compared to the non-responders (36.2%± 10.1), but the relation was not statistically significant (p:0.1).
- GLS: After 2 months, there was a statistically significant difference in the GLS between the responders (15.7±3.5) and the non-responders group (10.7±2.4) (p:0.001), and after 6 months, the relationship was also statistically significant between the responders group (19.2±4.2) and the non-responders group (9.5±2.4). (p:0.001).
- E/E ratio: After two months, there was a statistically significant difference in the E/E ratio between the responders (7.56.3) vs. (17.23.9) in the non responders group (p:0.001), whereas after six months, the relation was also statistically significant between the responders group (8.44.3) vs. (18.52.9) in the non responders group (p:0.001).

**V- L-Carnitine levels between responders and non responders groups (Table 5):**

There was no statistically significant difference regarding L-Carnitine levels between the responders and non responders at 2 months (25.4±5.8mmol/L vs 25.3±7.6mmol/L, p: 0.9) but after 6 months, carnitine level was higher in responders group (35±11.45 vs 27.86±2.5 mmol/L, p: 0.0.03) respectively.

**VI- Comparison between study and placebo group at different intervals (Table 6):**

1- Clinical outcome: After two months, there were more patients in group I with NYHA class II than in group II (72% vs. 40%, p: 0.001), and after six months, there were more (82% vs. 57.5%, p: 0.001).

2- Echocardiographic parameters: There was statistically significant increase in EF in group I at 2 months (39.3±8% vs 33.52±4.8%, p: 0.001) and after 6 months (40.33±8% vs 34.5±4.8%, p: 0.001) as compared to group II respectively. Regarding GLS (- %), group I exhibited significant improvement in GLS at 2 months as compared to group II (16.5±2.9 vs 7.7±2.8, p:

0.001) which continued after 6 months (18.8±3.6vs 8.2±1.5, p: 0.001) respectively. Regarding E/E′ ratio, group I exhibited significant improvement in diastolic function at 2 months as compared to group II (8.6±7.7 vs 18.2±4.3, p:**VII-** 0.001) which continued after 6 months (8.1±5.5vs 19.1±2.6, p: 0.001) respectively.

3- L-Carnitine: In group I, there was no statistically significant increase in serum L-carnitine levels after two months (22.4±6.3 vs. 19.4±2.5, p: 0.05), but there was a statistically significant increase in serum carnitine levels after six months (35.8±10.1 vs. 22.5±3.1, p: 0.01).

**Correlation between EF and L-Carnitine:**

L-Carnitine and EF had a statistically significant positive connection (r= 0.6, p=0.001) **(Figure 1).**

**Table 1: Deproteinization.**

| Pipette into 10ml centrifuge tubes | For serum |
|---|---|
| **Perchloric acid solution (0.6ml/l) ice-cooled samples (seminal plasma, serum plasma)** | **1.00 ml**<br>**1.00 ml** |
| **Mix properly, keep in an ice-bath for 10 minutes. Then pipette into fresh centrifuge tubes.** | |
| **Supernatant, may be slightly turbid potassium carbonate solution (approx. 1.2M)** | **1.00 ml**<br>**0.20 ml** |
| **Mix properly, keep in an ice-bath for 20 minutes, centrifuge at 3000xg (6000rpm, r= 7cm) for 5 minutes. The separated supernatant is stable for 5 days at 2-8ºC in a closed vial prior to work.** | |

**Table 2: Comparison between both groups as regards to clinical characteristics, risk factors and baseline L- carnitine levels for both groups using chi-square and t test.**

| | Group I (80pts) | Group II (80 pts) | p value |
|---|---|---|---|
| **Age (years)** | **54.6±10** | **55.4±7** | **0.6** |
| **Sex:**<br>**Male**<br>**Female** | <br>**42 (52.5%)**<br>**38 (47.5%)** | <br>**48 (60%)**<br>**32 (40%)** | **0.4** |
| **Hypertension** | **48 (60%)** | **50 (62.5%)** | **0.8** |
| **DM** | **36 (45%)** | **40 (50%)** | **0.8** |
| **Dyslipidemia** | **30 (37.5%)** | **46 (57.5%)** | **0.1** |
| **Smoking** | **56 (70%)** | **38 (47.5%)** | **0.07** |
| **Obesity** | **18 (22.5%)** | **34 (42.5%)** | **0.05** |
| **NYHA class**<br>**Class II**<br>**Class III and IV** | <br>**22 (27.5%)**<br>**58 (72.5%)** | <br>**28 (35%)**<br>**52 (65%)** | **0.6** |
| **L-Carnitine (mmol/L)** | **14.27±6.8** | **16.5±3.6** | **0.07** |

**Table (3): Evaluation of clinical outcome in group I.**

| Groups | 2 months | 6 months |
|---|---|---|
| **Responders** | **56 (72%)** | **36 (75%)** |
| **Non responders** | **22 (28%)** | **12 (25%)** |
| **Total** | **78** | **48** |

**Table 4: Echocardiographic parameters between responders and non responders groups at 2 and 6 months**

| | Responders | Non responders | P value |
|---|---|---|---|
| **EF%**<br><br>**2 months**<br>**6 months** | <br><br>**41±6.4**<br>**41±7.3** | <br><br>**35±10.3**<br>**36.28±10.1** | <br><br>**0.03**<br>**0.1** |

| | Responders | Non responders | P value |
|---|---|---|---|
| **GLS (- %)** | | | |
| **2 months** | **15.7±3.5** | **10.7±2.4** | **0.001** |
| **6 months** | **19.2±4.2** | **9.5±2.4** | **0.001** |
| **E/E′ ratio** | | | |
| **2months** | **7.5±6.3** | **17.2±3.9** | **0.001** |
| **6 months** | **8.4±4.3** | **18.5±2.9** | **0.001** |

**Table 5: L-Carnitine levels between responders and non responders at 2&6 months.**

| | Responders | Non responders | P value |
|---|---|---|---|
| **2 months** | **25.4±5.8mmol/L** | **25.3±7.6mmol/L** | **NS** |
| **6 months** | **35±11.45 mmol/L** | **27.86±2.5mmol/L** | **0.03** |

**Table 6: Comparison between group I and II as regards clinical outcome, echocardiographic parameters and L-Carnitine at different intervals.**

| | Group I | Group II | P value |
|---|---|---|---|
| **NYHA class II** | | | |
| **Baseline** | **22 (27.5%)** | **28 (35%)** | **0.6** |
| **2 months** | **56 (72%)** | **32 (40%)** | **0.001** |
| **6 months** | **64 (82%)** | **46 (57.5%)** | **0.001** |
| **Echocardiographic parameters** | | | |
| **EF (%)** | | | |
| **Baseline** | **35.7±7.5** | **32.5±4.3** | **NS** |
| **2 months** | **39.3±8.1** | **33.5±4.8** | **0.001** |
| **6 months** | **40.3±8** | **34.5±4.8** | **0.001** |
| **GLS (- %)** | | | |
| **Baseline** | **6.8±2.3** | **5.9±3.1** | **NS** |
| **2 months** | **16.5±2.9** | **7.7±2.8** | **0.001** |
| **6 months** | **18.8±3.6** | **8.2±1.5** | **0.001** |
| **E/E′ ratio** | | | |
| **Baseline** | **20±4.3** | **21±3.8** | **NS** |
| **2 months** | **8.6±7.7** | **18.2±4.3** | **0.001** |
| **6 months** | **8.1±5.5** | **19.1±2.6** | **0.001** |
| **L-Carnitine (mmol/L)** | | | |
| **Baseline** | **14.27±6.8** | **16.5±3.6** | **NS** |
| **2 months** | **22.4±6.32** | **19.4±2.6** | **NS** |
| **6 months** | **35.87±10.18** | **22.5±3.1** | **0.02** |

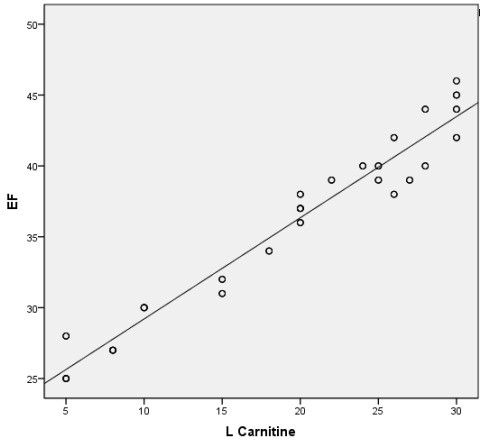


**Figure (1): Correlation between EF and L-Carnitine.**

## DISCUSSION

A major etiology of morbidity and mortality worldwide is congestive heart failure [10]. Lowered preload, decreased afterload, increased contractility, and interference with harmful neurohumoral pathways engaged in these situations have been the goals of therapy [11].

Despite the high efficacy of medical therapy to improve morbidity and mortality, some patients remain [12].

Inhibition of the enzyme systems that limit oxidative metabolism, such as the acyl-CoA carnitine transferase system, that is responsible for the transport of free fatty acids into the mitochondria, may also cause accumulation of metabolites to compromise cardiac function. At autopsy, the necrotic zone of human infracted myocardium shows a drop in free carnitine and an increase in acyl groups [13].

The myocardium can use many substrates for energy production, however, during coronary flow, 60% to 90% of ATP production results from oxidation of free fatty acids (FFA) [14]. Utilization of FFA depends on many factors, including the ACCT system [15]. During ischemic attacks, great changes in FFA metabolism occur. Reduction of oxygen supply results in inhibition of oxidation. During ischemia (>30min) oxidation of FFA is further inhibited due to lost free carnitine [16].

Myocardial metabolic and mechanical functions are impaired in ischemic myocardium due to buildup of oxidative metabolites, especially long-chain acylCoA esters [17].

Also long chain acyl carnitine accumulates and helps to the decrease in velocity of conduction and cell to cell uncoupling [18] The accumulation of acyl –CoA decrease the availability of intra mitocondrial free CoA which regulates the conversation of aketoglutrate to succinyl-CoA [19].

The intramitocondrial acetyl-CoA/CoA ratio also rises, which prevents the pyruvate dehydrogenase (PDH) complex from activating and causes pyruvate to be converted to lactate. The activity of the adenine nucleotide translocase, which controls the exchange of ATP for ADP across the mitochondrial membrane, is decreased by long chain acyl-CoA esters. As a result, mitochondria sequester ATP, which causes cytosolic ATP to decline.

Due to its cardioprotective properties against hypoxia and oxidative stress, L-carnitine may aid in the treatment of several heart disorders. Impressive studies were conducted about the role of carnitine delivery to patients with MI, angina, and congestive HF. By restricting the increase in left ventricular end systolic and end diastolic volume, carnitine supplementation (1.5 to 6 gm/d for up to 1 year) reduces both morbidity and mortality. Carnitine treatment may lessen symptoms in studies lasting 1 to 3 months. Additionally, carnitine appears to increase heart failure patients' capacity for exercise and oxygen uptake [20].

Carnitine myocardial beneficial effects may be attributed to:

1- Transporting active long-chain acyl-CoA esters into the mitochondria, which helps beta-oxidation.
2- Increasing the citric acid cycle's metabolic flux by keeping free CoA and reducing the acetyl CoA/CoA ratio, which in turn increases the activity of PDH and glucose oxidation and improves the effectiveness of L-carnitine supplementation as an additive therapy.
3- By avoiding the inner mitochondrial membrane's inner mitochondrial membrane's suppression of adenine nucleotides (ATP, ADP) [21].

Global longitudinal strain (GLS), a fundamental metric, expresses longitudinal shortening as a percentage (change in length as a proportion to baseline length). GLS is obtained from speckle tracking and evaluated using apical pictures of the LV that have undergone post-processing. GLS is derived differently by software from various manufacturers. View selection, specifying end-systole, tracing the myocardium, evaluating tracking quality, and integration are nevertheless common aspects. Different strain-related characteristics can manifest in various ways. Waveforms can be utilized to show temporal dispersion and contraction delay in various cardiac segments. To show how spatial dispersion changes during the course of the cardiac cycle, parametric displays can be employed. GLS typically varies with age, sex, and LV loading conditions, hence it can be challenging to diagnose abnormal GLS. GLS 16% is abnormal in adults, GLS >18% is normal, and GLS between 16% and 18% is borderline. GLS is expressed as a number that is negative [22]. E/e′ ratio could reliably estimate of LV filling pressure in systolic and diastolic HF, also in atrial fibrillation [23].A left ventricular diastolic dysfunction indicator is an E/E′ ratio over 15. A result of less than 8 can be regarded as normal, and intermediate levels fall into the "grey zone" [24].

This study includes 160 patients who were admitted to Critical Care Department at

Zagazig university with dilated cardiomyopathy, 80 patients (group I) received L-carnitine in a dose of 3gm/d plus conventional anti-failure treatment and were followed-up, the other 80 patients (group II) received conventional anti failure treatment only. We found that 56 out of 80 (72%) patients in group I who received L-carnitine plus conventional anti failure treatment showed improved outcome after 2 months, follow-up in the form of improved clinical symptoms and signs of heart failure, NYHA class and improvement in echo parameters namely EF , LVEDD, GLS and E/E′ ratio respectively. However after 6 months 64 (82%) patients showed improvement vs 14 (18%) pts who are non-responders. Also, the responders group showed progressive improvement regarding EF, LVEDD, GLS and E/E′ ratio after 2, 6 months as compared to non-responders group.

In addition, patients in the study group (group I) exhibited significant life quality improvement, echocardiographic parameters and serum L-Carnitine levels as compared to the placebo group (group II) after 2 and 6 months follow-up. This finding was in agreement with the randomized study was in agreement with the randomized study conducted by Gurlek et al, 2000 who examined 51 individuals with ischemic cardiomyopathy, supplying 2 gm/day of L-Carnitine effects on erythrocyte superoxide dismutase (SOD) activity and LV systolic function were compared to those of no carnitine supplement. Patients' red blood cells had significantly increased SOD activity (5.6331.225 versus 3.202373U/g of haemoglobin; p>0.05) [25]. Carnitine supplementation may improve LV-EF and FS, according to Loomba et al (2020). Carnitine supplementation seems to work best for people who have lower EF and FS. Carnitine therapy lasted an average of 9.8 months. After carnitine supplementation, the LV-EF increased with a mean difference between groups of 3.56 (p: 0.04). After carnitine supplementation, the LV-FS was greater, with a mean difference between groups of 3.68 [95% confidence interval 1.22-6.15, p-value 0.01]. After supplementing with carnitine, the left ventricular end diastolic diameter increased, although the difference was not statistically significant [26]. In a prior study, Wang et al. found that giving carnitine in addition to standard care significantly improved the EF and FS in children with DCM. Additionally, individuals who received carnitine supplements had smaller biventricular diameter, indicating an advantage of carnitine supplementation over traditional therapy, according to this study [27]. Similar findings of increased EF, FS, and EDD were also reported by Kotby et al. The clinical signs, especially improvements in effort tolerance, were also found in both investigations [28]. In children receiving hemodialysis, levocarnitine supplementation increased the longitudinal strain rate [29].

According to Lyer et al., 50 patients with congestive heart failure (CHF) (NYHA class I) who were symptomatic despite treatment and had an EF below 45% experienced effects from palmityl L-carnitine (PLC). For six months, the patients were randomly assigned to receive either 1.5g/day of PLC or a placebo by mouth. They discovered a substantial increase in the maximal exercise time (1 minute longer) in the treatment group compared to the placebo, also significant reduction in lactate production. The treated group should significant increase in LV-FS and EF mainly after 1 month (30). In 2000, Lyer et al. studied 47 individuals with chronic stable angina to test the effectiveness and safety of oral carnitine vs placebo. Patients receiving carnitine were given 2g/d for three months. Exercise duration, onset time for ST changes, peak exercise total ST score, peak exercise rate-pressure product, and recovery time for ST changes to baseline were considered. At the start and conclusion of the experiment, computerized stress tests were used to analyze all parameters. At the end of three months, exercise time increased from 7.8 ±2.2 to 8.6 ±1.2 minutes in the carnitine group (p = 0.006), and the amount of time required for ST alterations to return to baseline decreased from 7.2±3.9 to 5.7±3.8 minutes (p= 0.019). Time to ST depression onset, ST score, or rate-pressure product did not alter. In neither group were there any systemic side effects or coronary incidents. Thus, carnitine prolonged exercise and sped up the recovery from ST alterations in patients with chronic coronary syndromes [30].

For the treatment of NYHA III and IV heart failure presented by dilated cardiomyopathy, the effectiveness of long-term carnitine therapy (2 gm/d) against placebo was evaluated in 70 patients. Prior to participation, all patients had been receiving conventional therapy for one to three months with clinical stability. This includes ACE inhibitors, digoxin, and diuretics. After three months of treatment, the researchers found that individuals taking carnitine had statistically significant increases in their peak oxygen consumption (VO2max), maximum time for a cardiopulmonary exercise test, arterial and pulmonary blood pressure (BP), and cardiac output. Six people died in the placebo group,

compared to one death in the carnitine group. The group that received carnitine demonstrated enhanced long-term patient survival (33211.8 months of follow-up; p>0.04; Kaplan-Meier analysis) [31].

In a pediatric, multicenter, retrospective investigation, various metabolic reasons of cardiomyopathy were investigated, and the study's effectiveness was assessed. Carnitine was administered to 76 patients in addition to standard cardiac care, whereas standard care alone was administered to 145 patients. Patients ranged in age from one day to eighteen years old and were diagnosed with various forms of cardiomyopathy. A metabolic issue may be the cause of cardiomyopathy in 29 patients who received carnitine (38%) and in 15 of 145 untreated patients (10%), according to the research. Treatment with carnitine lasted somewhere between two weeks and more than a year. Information on length was gathered. From the beginning of the study to its end point, death, organ transplantation, or last known follow-up visit, data were gathered at regular intervals. According to the researchers, carnitine was clinically effective in treating pediatric cardiomyopathy. However, it's possible that patients with more severe cardiomyopathy were more likely to receive ACE medications [32].

## CONCLUSION

L-Carnitine supplementation as an adjunctive therapy for patients with dilated cardiomyopathy appears to have positive impact on the clinical outcome but we need large scale controlled study to assess its efficacy in patients with DCM.

**Conflict of Interest:** None

**Financial Disclosures:** None

## REFERENCE

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