

Protective Effect of Coenzyme Q10 in Children with Heart Failure

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Review Article

Jhonnier Rafael Villero Suarez^{1*}, Juan Rafael Farak Gomez¹, Alba Vellojín Olivares², Juan Tafur Delgado³, Fabiola Menco Contreras³, Luis Meza Delgado⁴ and Mauricio Meza Delgado⁵

¹GINUMED research group, Medicine Program, Rafael Nuñez University Corporation, Cartagena, Colombia

²First-year pediatric resident at the Sinú University, Colombia

³Second-year pediatric resident at the Sinú University, Colombia

⁴6th year medical student from University of Sinú, Colombia

⁵5th year student of medicine at the Rafael Nuñez University Corporation

*Correspondence author

Jhonnier Rafael Villero Suarez

GINUMED research group

Medicine Program

Rafael Nuñez University Corporation

Cartagena

Colombia

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Abstract

Background: Heart failure is considered a health problem caused by its high mortality, morbidity and high costs of care. The causes of Heart Failure in children differ from that of adults, with the most frequent causes in children being congenital heart disease and cardiomyopathy. Coenzyme Q10 acts as an energy transfer molecule, occurring in organs with high metabolic levels, such as the heart, kidneys and liver.

Methodology: A narrative review was carried out through various databases from January 2005 to January 2021; the search and selection of articles was carried out in journals indexed in English. The following keywords were used: Coenzyme Q10, children, Heart Failure, Pediatrics.

Results: Supplementation with Coenzyme Q10 has beneficial effects on different etiological variants of heart failure in children, thanks to the prevention of oxidative damage to the defective myocardium, as well as the increase in bioenergetics and its strong antioxidant properties, provided by its important role as an electron carrier in the transport chain.

Conclusion: This review offers recommendations to use Coenzyme Q10 as a complementary treatment in Heart Failure in different etiological variants.

Keywords: Coenzyme Q10; kids; Heart Failure; Pediatrics.

Introduction

Heart failure has been determined as an alteration in cardiac structure or function that causes the heart not to supply oxygen at a rate consistent with tissue requirements, even when filling pressures are normal [1]. The causes of Heart Failure in children differ from that of adults, with the most frequent causes in children being congenital heart disease and cardiomyopathy. Presenting characteristic symptoms and signs that include edema, respiratory distress, growth retardation and exercise intolerance with circulatory alterations, neuro-hormonal and molecular disorders [2].

Heart failure is considered a health problem caused by its high mortality, morbidity and high costs of care. It is estimated that, within 10 years, more than 8 million people in the United States will have some form of heart failure with a projected cost of 160 billion. Although data on the healthcare costs of heart failure are lacking, it has been reported that there has been a nearly two fold increase in hospitalization costs associated with pediatric heart failure [3].

Coenzyme Q10 is synthesized in the mitochondrial membrane and is considered an essential compound for the human body. This belongs to the chemical group of quinones with a highly lipophilic character [3]. Coenzyme Q10 has a low polarity which facilitates its rapid diffusion through the mitochondrial membrane, with the number 10 indicating the isoprenyl units. The oxidized form (ubiquinone) and reduced (ubiquinol) are the two forms of presentation of said Coenzyme [4]. This acts as an energy transfer molecule, occurring in organs with high metabolic levels, such as the heart, kidneys and liver [4, 5].

In cardiovascular diseases, this coenzyme could be reduced, since the inflammatory processes could be exacerbated as a result of its exhaustion, with subsequent activation of the inflammatory signaling pathway and the induction of free radicals [5]. In today's world, many do not have access to medical care and die of Heart Failure every year, likewise there is little published research on the treatment of Heart Failure in Children [4]. Therefore, this review aims to provide what are

the protective effects of Coenzyme Q10 in children with Heart Failure and describe in what type of Heart Failure Coenzyme Q10 has a protective effect.

Materials and Methods

A narrative review was carried out, in which the PubMed, Scielo and Science Direct databases, among others, were searched. The collection and selection of articles was carried out in journals indexed in English from 2005 to 2021. As keywords, the following terms were used in the databases according to the DeCS and MeSH methodology: Coenzyme Q10; kids; Heart failure; Pediatrics. In this review, 68 original and review publications related to the subject studied were identified, of which 22 articles met the specified inclusion requirements, such as articles that were in a range not less than the year 2005, which were articles of full text and to report on the protective effects of Coenzyme Q10 in children with Heart Failure and its etiological variants. As exclusion criteria, it was taken into account that the articles did not have sufficient information and that they did not present the full text at the time of their review.

Results

Protective Effects of Coenzyme Q10 in Children with Heart Failure

In the mitochondria of all cells, Coenzyme Q10 is an indispensable member of the respiratory chain. This, through the regeneration of tocopherol and ascorbate from their oxidative state or direct reaction with free radicals, provides a basis for antioxidant action [6].

This coenzyme has beneficial effects, demonstrated by the increase in the left ventricular ejection fraction, stroke index, as well as improving the quality of life of hospitalized pediatric patients with a reduction in their hospital stay and a decrease in mortality and morbidity [7].

This modulation of cardiac energy could represent a therapeutic option in children with heart failure. Among the common findings found in children with Heart Failure, we find mitochondrial dysfunction, ATP depletion, and abnormal calcium management, with subsequent energy depletion leading to a deficit in cardiac contractile function [8].

Epigenetic regulation in genes involved in cell signaling and improvement of endothelial function is provided by this Coenzyme, as well as an improvement in ATP production [8, 9]. Therefore, the alteration of the main source of this coenzyme, the mitochondrial membrane, either by the activation of the immunoinflammatory pathways and the overproduction of reactive oxygen species, is associated with the progressive onset of atherosclerosis, caused by the overwhelming of the defense of the antioxidant cellular enzyme [9].

Improvement in Left Ventricular Ejection Fraction and heart failure with preserved ejection fraction has been associated with Coenzyme Q10 supplementation, as well as a significant

increase in maximal exercise capacity [9]. Improving your quality of life by reducing common symptoms such as fatigue, exercise intolerance and inability for daily activities [10].

In Vitro and in Vivo studies found that there is a direct correlation between low levels of Coenzyme Q10 and high levels of oxidants in the mitochondria, and these in turn were associated with a decrease in the mitochondria of muscle and fat resistant tissue. Insulin, caused by a change in the expression of the proteins of the mevalonate/Coenzyme Q10 pathway [11]. After the administration of the Coenzyme, a significant improvement was found in the evaluation of the Homeostatic model of insulin resistance in pediatric patients with metabolic syndrome [12].

This Coenzyme has multiple benefits, as has been described, highlighting the prevention of oxidative damage of the defective myocardium, as well as the increase in bioenergetics and its strong antioxidant properties, provided by its important role as an electron carrier in the transport chain [13].

Coenzyme Q10 and the Etiological Variant of Heart Failure in Children

The different needs of Coenzyme Q10, it is possible that they are demanded by the types of Heart Failure. As well as the etiology or severity of the disease, they may require a greater or lesser amount of Coenzyme Q10 Supplementation [14].

In pediatric patients with dilated cardiomyopathy, after the administration of Coenzyme Q10 they showed an improvement in cardiac contraction by delaying myocardial damage, and after 24 weeks of administration they showed a decrease in cardiac enzymes, indicative of cell injury. such as CK, CK-MB, BNP, and NT-Pro. The inflammatory cascade of NF- κ B Activation is inhibited by the anti-inflammatory nutrient effect of Coenzyme Q10 [15].

Dilated Cardiomyopathy: After the administration of Coenzyme Q10 in pediatric patients, an improvement was shown in the functional class of the NYHA [16]. However, the therapeutic effects depend on the basal plasma and myocardial levels, being the deficiency of Coenzyme Q10 reversible [17].

Hypertrophic Cardiomyopathy: The improvement of fatigue and dyspnea symptoms was shown after the administration of coenzyme Q10. As well as a 24% decrease in the mean thickness of the interventricular septum in pediatric patients [18].

Restrictive Cardiomyopathy: After the administration of Coenzyme Q10 in pediatric patients, an improvement in the clinical and hemodynamic parameters was shown. Taking into account that this Coenzyme tends to decrease in Restrictive Cardiomyopathy [19].

Toxic Cardiomyopathy: In Vivo and in Vitro studies demonstrated the prevention or possible inhibition of the toxic effects caused by doxorubicin, with subsequent cardiomyopathy [20].

Ischemic Cardiomyopathy: After the administration of Coenzyme Q10, an improvement in functional capacity was

shown, with a subsequent reduction in cardiovascular events and a decrease in mortality [21].

Discussion

Supplementation with Coenzyme Q10 has beneficial effects on different etiological variants of heart failure in children, thanks to the prevention of oxidative damage to the defective myocardium, as well as the increase in bioenergetics and its strong antioxidant properties, provided by its important role as a carrier of electrons in the transport chain. Taking into account that the heart is the one with the highest concentration of Coenzyme Q10.

The level of coenzyme Q10 in pediatric cases has been scarcely studied, but other studies such as that of Angkawipa et al. in which it includes a meta-analysis of 375 articles of which 1662 people including pediatric patients, agrees with our study by supporting the use of Coenzyme Q10 combined with standard therapy in heart failure to reduce mortality, partially explaining the benefit by the inverse remodeling of the left ventricle [22].

A strength of the current study is the methodology implemented, with respect to the literature search, and steps in the selection of relevant articles, quality assessment and data extraction. However, this study has several limitations, which should be taken into account before reaching a conclusion, among these are the little evidence from analysis of large-scale clinical trials to accurately determine the effectiveness and safety of Coenzyme Q10 in heart failure in pediatric patients.

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