

The Heart Physiology in Fertile Female and The Heart Pathophysiology in Post Menopausal Female. The Contribution of Molecular Biology, Maintaining Cardiac Hemodinamy and Electrophysiology

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Opinion Article

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Introduction

The physiology of the heart in fertile women and the heart of the female sex in mammals is a masterpiece of evolution over 150 million years. Hormones, after female sexual maturation, prepare the heart to overcome the efforts during pregnancy and childbirth. In female animals, molecular biology does not differ from that of humans. However, during childbirth, animals generally do not have difficulties, given that the shape of the head and the size of the hips (which have a protruding brain, require a great physical effort accompanied by extreme pain in women. This phenomenon appeared when Homo sapiens developed a large forehead (significant growth of the frontal lobes, which occupy 36-38% of the brain size compared to 19% in chimpanzees and 8% in dogs.

Estrogen and collagen in the heart; there are 2 types of collagen in the heart, [1] secreted by the fibroblast, hard collagen (collagen I) that maintains the structure of the heart, and collagen III, soft collagen, which functions to maintain the myocardium's ductility during diastole.[2] The ratio between collagen I and III is 1/3, suggesting that under basic conditions, there is more hard collagen than soft in the heart. During pregnancy, the ratio is reversed in favor of collagen III/ [3]_. This increase in collagen III allows greater ductility to the left ventricle, increasing diastolic capacity. This diastole increases the cardiac minute volume by a third, without increasing the heart rate [4]. A marathon runner needs more than 150 beats per minute to increase his minute volume by a third. It is estimated that the effort of a woman during pregnancy spends the same energy that an Olympic runner would in 18 competitions. Also, estrogen stimulates the fibroblasts to secrete more collagen III in the right atrium. This dilation increases the entry of blood flow, contributing to an increase in cardiac output. [5]The physiology of the right atrium's fibroblast is similar to that of the abdominal skin, as it also stretches due to a significant increase in collagen III.

Estrogen and adrenaline

Estrogen has control over the adrenaline secreted from the adrenal medulla and the adrenaline secreted from the sympathetic system.[6] This control is of utmost

importance during childbirth, given the effort and pain, a large amount of catecholamines are secreted, and stimulating the beta receptors can be very harmful to the integrity of the cardiac muscle.[7]

Estrogen and calcium metabolism

Calcium levels can vary throughout the month. During the premenstrual period, when there is a decrease in estrogen, there is also a decrease in calcium. In the heart, there is an enzyme, osteopontin, which protects this organ from excessive calcium deposition and directs it towards the bone system[8]. Estrogen controls cAMP in the entry of calcium channels to the cardiac sarcoplasm (calcium reservoir in the myocyte).[9] During systole, calcium enters the myocyte through a physical phenomenon, without the need for energy. During diastole, to release calcium from a low concentration area towards the sarcoplasmic reticulum, a pump, SERCA (Sarcoplasmic Endoplasmic Reticulum Calcium ATPase), [10] and an enzyme, phospholamban, are needed to reinforce it. Both SERCA and the latter are controlled by estrogen.[11] Therefore, estrogen has a critical importance in diastolic function and, along with the increase of collagen III during pregnancy, to increase cardiac output.

Estrogen and mitochondria

Mitochondria provide energy to the cardiac muscle. The mitochondrion, with glucose, fatty acids, and oxygen, produces adenosine triphosphate (ATP).[12] Through fission, ATP loses a phosphate anion. This produces heat and energy. Mitochondria have the biology and morphology of a bacterium and reproduce by fission. [13] During efforts, mitochondria reproduce, depending on the heart and muscles' energy intensity.[14] During pregnancy, the heart's energy need increases exponentially, so mitochondria are stimulated by estrogens to reproduce to meet energy needs. Estrogen receptors alpha and beta are found on the membranes of mitochondria, suggesting the importance of this hormone in heat and energy production. [15] It is logical to assume that the heart during pregnancy requires enormous energy to increase cardiac output by a third.

The pathophysiology of the heart in postmenopausal

Inhypoenestrogenemia, the fibroblast produces more collagen I than III,[16] in the subendocardium of the left ventricle, and in the right atrium. From collagen I, fibrosis forms. [17]This subendocardial fibrosis complicates diastolic relaxation. (12)Increasing the heart rate increases the final diastolic pressure.(fig1) This hemodynamic phenomenon is reflected in dyspnea on effort, and in the case of very high frequencies, such as atrial fibrillation, can cause acute heart failure with normal cardiac contraction. In the right atrium, the fibroblast secretes collagen I, resulting in atrial fibrosis.The fibrotic right atrium is the basis for arrhythmias; And non-sustained ectopic atrial tachycardia,(fig 2) which can evolve into limited atrial fibrillation.(fig 3)The diastolic function is altered by the dysfunction of hypoenestrogenemia in calcium metabolism.[18] In the reduction of estrogen, the calcification of mitral annulus, aortic valve and, coronary arteries[19]

Estrogen has a critical function in the pump, SERCA, and phospholamban in transporting calcium to the sarcoplasmic reticulum. Therefore, this phenomenon contributes to diastolic dysfunction and an increase in final diastolic pressure[19].(fig 1)

In extreme emotional situations, with high secretion of adrenergic substances, the myocardium is exposed to severe injuries, and due to the lack of estrogen control, it causes severe dyskinesia, which can trigger mortality. This phenomenon is called tako-tsubo, [20] occurring in 99% of women and 95% in postmenopausal women.

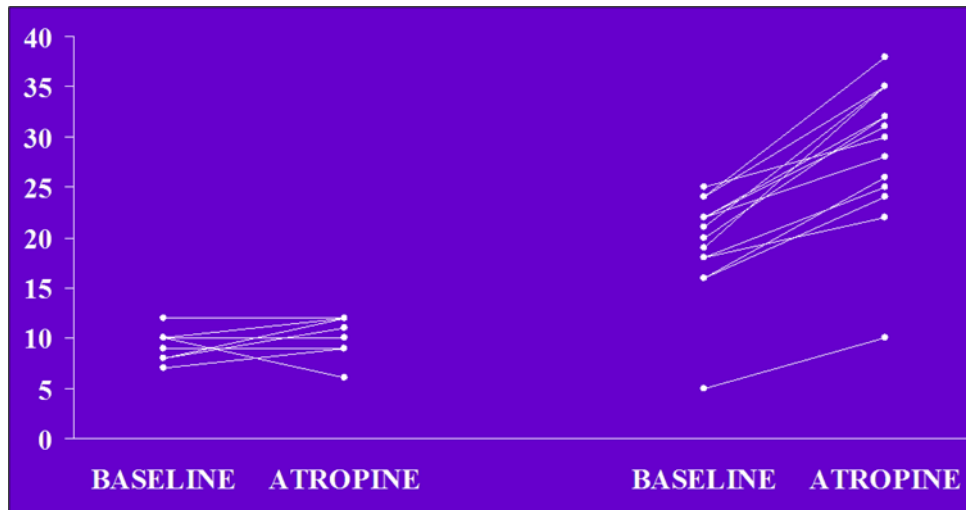


Figure 1. Sclarovsky S and Hartz I 1994 Assuta Medical Center

It is also logical to speculate that the heart of the postmenopausal woman has less cardiac energy due to hypoestrogenemia and the hormone's stimulating effect on alpha and beta receptors in the mitochondria's membrane.

Left side

5 women 30 to 49 years old

With angina pains

ECG inverted T waves in precordial leads

Cardiac ultrasound normal

Coronariography normal

Left diastolic pressure normal

After atropine no changes in intracavitary pressure

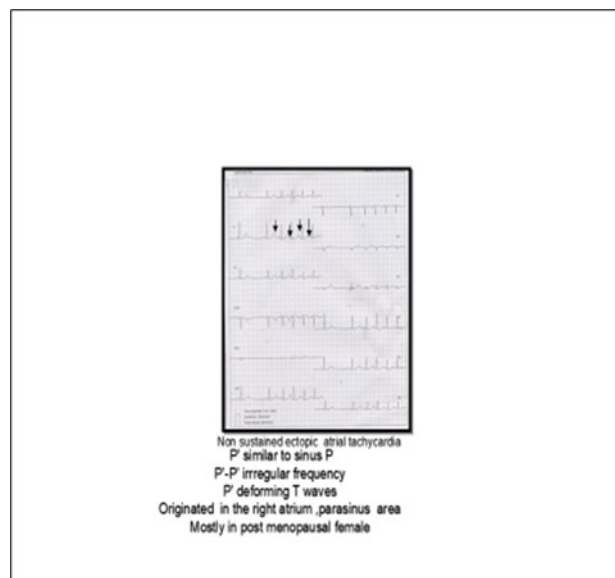


Figure 2

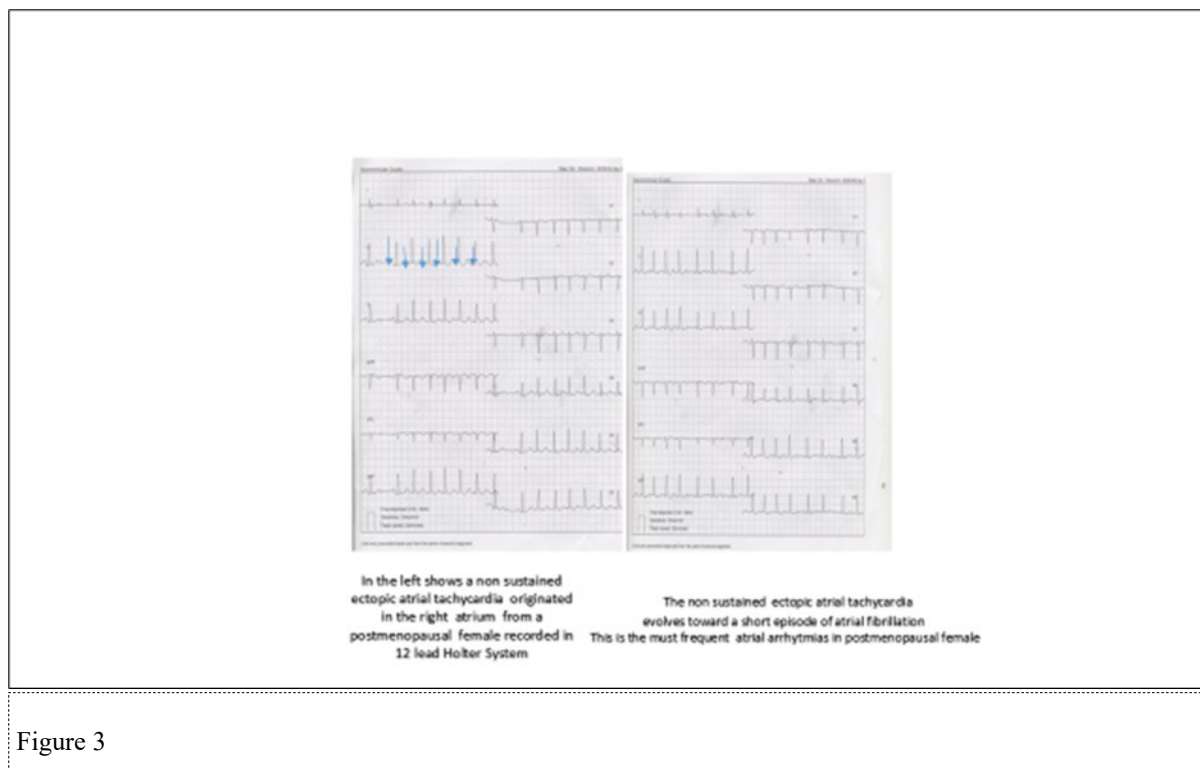


Figure 3

Intracavitary pressure suggesting severe diastolic failure
 right side
 10 postmenopausal women
 with angina pains and dyspnea
 with ST depression in v4.v5.v6
 ultrasound signs of diastolic dysfunction
 coronariography normal
 high diastolic pressure at rest
 after atropine marked increase in I

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