

## Review Article

# Aging-Related Changes of the Cardiovascular System

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**Abstract:** The cardiovascular system (CVS) is associated with many complex changes during aging both in structure and function, which leads to alterations in of the cardiovascular physiology that differ from pathological effects such as disease of the coronary arteries. The changes related to age seen in everyone but not necessarily at the same rate. The related change of the CVS with aging includes slight hypertrophic heart that become sympathetic stimuli hypo-responsive, an increased arteries hardness and stiffness and a diminished in elasticity as the aorta and main arteries become stiffer and elongated with increased velocity of pulse wave, dysfunction of endothelial and early atherosclerosis resembling biochemical patterns.. Many studies have declared that the process of aging has major alterations for CVS and increased cardiovascular disease (CVD) prevalence with advancement of ages. The aging roles on the CVS are a subject of intense researches and interest. The presented review highlights the major CVS associated changes with aging in healthy individuals and associated disease process and perspectives of future directions.

**Keywords:** Aging-Related Changes, Cardiovascular System, Myocardium, Cardiac Function, Blood Vessels and Vascular Function

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## 1. Introduction

The phenomenon of aging was explained by a lot of theories; among these most widely accepted biological theories are (1) tear and wear, (2) neuro-endocrine theory, (3) mitochondrial theory, (4) waste accumulation theory, and (5) telomerase theory [1, 2, 3]. The above-mentioned theories can explain physiological changes, which occurs with advancement of age. aging related changes to cardiovascular involved mainly decrease in rates of the heart, extraction of oxygen, stiffening of the arteries, vasoconstriction, systolic blood pressure elevation, myocardial thickening, diastolic filling rate reduction, in rhythmic rates alterations, and prolongation of action potential were described earlier by different researcher [4]. Structural and functional changes was found to be directly associated with aging in autonomic nervous system (ANS). Changes were found in autonomic nerves and ganglia. Recording from sympathetic nerves of skeletal muscle also revealed significant changes. Researchers suggested that aging might enhance basal nor-epinephrine level and depress heart rate variability [5, 6].

Aging is accompanied by some organ progressive dysfunction that hinders the homeostasis. no senility definition is reported. The World Health Organization define the age of >60 is senility whereas American classifications 65 years is the borderline between maturity and senility [7]. Aging was believed by most investigators was result in oxidative stress, and aging of the cardiovascular system [8, 9]. CVS aging resembles the changes described in inflammation both morphologically and biochemically while different effects of aging related to the CVS are not fixed changes [10].

## 2. Structural Changes Related to Age

Progressive cardiac structures degeneration was noticed with aging, including elasticity loss, heart valves fibrotic changes and amyloid infiltration. The heart pumping capacity is decreases with advanced age due to different changes affecting the function and structure of the muscle of the heart [11]. With the advancement of ages the heart undergoes atrophy, heart mass was increased with decreased number the myocardial cells were declines [12].

Aging were associated with weight of the heart showed mild increase due to left ventricular enlargement even in persons that suffered no hypertension, increased dimensions of cardiomyocyte with decreased its numbers and prominent collagen and the sympathetic nerve supply of cardiac showed a partial degeneration and also cardiac responsiveness to  $\beta$ -adrenergic stimuli was altered in the aging heart [13]. Changes of the heart associated with aging causes slight different of the ECG, slight degeneration of the cellular cardiac muscle, depositions of the lipofuscin and stiffer heart valves which control the blood flow directions leading to murmur of the heart [7, 14]. With aging the myocytes were dropout together with the increased left ventricular (LV) after-load and hypertrophy of the LV. ECG researches that calculated LV mass by measurements of the thickness of the wall correlated these findings [12, 15].

Arteries stiffness and increased Wall Thickening during aging demonstrate a clear effect on cardiac structure and function. As noted increased systolic blood pressure with age. A hypertrophy is caused by cardiac myocytes enlargement due to addition of more sarcomeres. Also a diminished in number of myocyte myocardium and all heart structures become more rigid with increasing aging [16]. The left ventricle musculature appeared thicker with slight increase in heart size, and the size of the left ventricle may decreased. Heart rate and cardiac output that were increased in response to physical activity is also decreased [9].

Contraction–Excitation of the myocyte showed great changes during increasing aging as prolonged action potential leading to contraction prolongation [17]. The prolonged action potential was due to a decreased of the cation uptake [9]. The DNA containing nucleus appeared larger with membrane invagination and alterations in size and shape of the mitochondria [18].

### 3. Cardiac Function Changes and Age

Aging generally has no great change on heart rate at rest as in the position like supine one at rest, heart rate appeared no differences between the older and young men [9]. The main cardiovascular system changes during aging decreased heart rate and adrenergic modulation of cardiac function [19]. While (Pal et al., [20] said that changes in rhythm of the heart places the aging population at increased risk.

Although aging with its accompanied alteration that may decrease the functional capacity and promote vascular stiffening, at rest cardiac muscle systolic function does not change with aging in healthy person while there are a number of changes in the diastolic phase of the cardiac cycle that occur with aging. Blood filling the heart was more slowly in older than younger healthy individuals resulting in a decreased of total diastolic filling at, early phase of passive diastole [21].

## 4. Vasculature and Aging

### 4.1. Arterial Stiffening of Arteries and Increased Thickness of Its Wall

Many researches has documented that during aging the

thickening and dilation of the wall of large elastic arteries are the main structural changes. The thickening of wall involves mainly the intima and the media tunics that leads to a decrease in arterial compliance with an increase in stiffness of vessels [19, 22]. The increased thickening and stiffening of wall in aging was due to more collagen, elastin reduction, and calcification. Like changes could not be “atherosclerotic”. Arterial thickening of the age-dependent occurs in the absence of atherosclerosis as arterial aging is likely an adaptive mechanism to maintain flow of blood and tension inside wall [23].

When they become stiffness of large arteries, leading to an increase in arterial systolic pressure, a decrease in diastolic pressure and a widening of the pulse pressure. This like vasculature changes is much different from that seen in hypertension, for which there is total peripheral resistance increase. that tends to elevate the systolic and arterial pressure [9].

### 4.2. Dysfunction of Endothelium

During the aging process, large arteries stiffening can be due to a in endothelial function reduction, which normally opposes contraction of the underlying smooth muscle vasculature and nitric oxide (NO) reduction, such reduction is thought to be mainly the result of an increase in oxidative stress and increased endothelial permeability during aging [24].

The arterial vessels decrease elasticity with aging may contributed to chronic elevation of the diameter and wall rigidity of the vessels, which hindering its function the most important changes seen in the aorta, the wall of the aorta becomes less flexible and stiffened wall, so that the leaving of blood the left ventricle of the heart is combated by more resistance and cannot travel as far into the arteries [18]. Age-associated changes also includes less flexible, stiffer and wall thickness of the peripheral arterial vessels throughout the body. The veins walls also thickened with age due to an increased in deposition of connective tissue and calcium leading to development of veins varicoses. Due to veins blood pressure was low these alterations are not significant for function of CVS but may be of performing a role in the occurrence of phlebitis and formation of thrombus [20].

cardiovascular homeostasis may be affected by age through increased velocity of pulse wave and ejection time prolongation enhancing summation of arterial waves either antegrade or retrograde, leading to to increase of both pulse and systolic blood pressures in aging. leading to favoring onset and/or progression of vascular damage and increased risk of adverse physiological or clinical outcomes, including excessive cardiac workload and oxygen demand, left ventricular hypertrophy, further function of endothelium may altered in aging coronary vessels which contributed as coronary risk factors [22].

## 5. Valves

An age-related valvular circumference increase has been reported in aortic, semilunar bicuspid and tricuspid valves with the most alteration seen in the aortic valve. deposition of

calcify results on the stiffness of valves are. These alterations does not leads to significant dysfunction, although in some aged persons, severe aortic valvular stenosis and mitral valvular insufficiency are related to degenerative changes with age. Sclerosis of the aortic valve is detected in 80% of aged persons [18, 25].

## 6. Response of Cardiovascular System During Exercise and Aging

The maximum heart rate achievable was decreased after exercise with age and the maximum in the adult was 220 beats per minute as in the older adult, the lower heart rate is due to a decreased in the effect of vagus on heart rate at resting and the diminished in vagal tone possible in response to exercise. With aging, similarly an increased cardiac output with increasing workloads in various age groups. During extreme exercise, the young adult showed a more elevation in heart rate from rest to exercise at resting but is decreased in healthy older subjects [26].

## 7. Blood Pressure

Cardiovascular efficiency is measured by Blood pressure. Although in older (53.54) blood pressure is raised, there is no effects of aging on cardiovascular index, The blood pressure is monitor and by baroreceptors that help to maintain a fairly blood pressure constant when a person changes positions or is doing other activities. with aging the baroreceptors become less sensitive which clear that many older people have orthostatic hypotension [27].

## 8. Conclusion

CVS is associated with many complex changes during aging both in structure and function, which leads to alterations in of the cardiovascular physiology CVD and cardiac reserve diminishing, heart thickened and stiffens were increased by aging. There little diminishing in contractility of myocardium, but there is decrease of relaxation in the ventricles. Aging large arteries are tortuous, thickened wall, elongated with enlarged lumen. dysfunction of the diastolic pressure, which leads to the establishment of diastolic failure of the heart; dysfunction of endothelium, which may leads to atherosclerosis; Cardiopulmonary reflex is decreased, which leads to disturbances of electrolytes, derangement of homeostasis, and microcirculation disturbance. However, it is no clear if changes related to ageor changes due to another etiology. I recommended performing an additional experimental research and clinical studies with age and CVS

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