Effect of Aging on Cardiac Function Plus Monitoring and Support

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KEYWORDS

- Elderly surgical patient • Elderly cardiovascular anatomy
- Elderly cardiovascular physiology • Cardiovascular monitoring
- Elderly cardiovascular resuscitation

KEY POINTS

- Elderly surgical patients are common and often require evaluation and support of the cardiovascular system.
- Aging significantly affects ventricular and vascular anatomy, resulting in altered cardiac functionality.
- Physiologic changes of aging include a blunted baroreflex and altered β-adrenergic responsiveness, resulting in a decreased dependence on chronotropy and an increased reliance on stroke volume in response to stress.
- Monitoring of the elderly cardiovascular system is valuable and can be achieved in several noninvasive and invasive methods.
- Management of shock in the elderly benefits from an understanding of the needs of the specific patient and a recognition of the risks and benefits of each cardiovascular medication.

INTRODUCTION

The world's population is aging and increasingly requiring medical and surgical therapy. As a consequence, growing populations of patients require care based on a specialized knowledge of the physiology of aging. Cardiovascular disease remains the most prevalent and influential comorbidity affecting outcomes in the elderly surgical patient. Although the elderly account for only 6% of the population, these individuals experience 30% of all myocardial infarctions (MIs) and 60% of all associated

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deaths.[1] The unique physiology of the aging cardiovascular system as well as the impact of these changes during the stress of surgery is presented in this article (Table 1). Further, the necessary response to these changes is discussed with attention to methods of monitoring and recommendations for providing supportive care.

EFFECT OF AGING ON THE RIGHT VENTRICLE

The right ventricle is connected in series to the left ventricle (LV) and is, therefore, obligated to pump the same stroke volume. As the cardiovascular system ages, this relationship is not always maintained and right heart flow may not always equal left heart flow. Both systolic and diastolic right ventricular function may be impaired with normal aging as demonstrated using echocardiographic techniques. Studies using M-mode echocardiography in combination with Doppler technology in healthy elderly volunteers have been able to explain impaired right ventricular systolic function. The tricuspid annular plane systolic excursion (TAPSE) estimates the longitudinal contractile properties of the right ventricle. These modalities demonstrate a significant reduction in TAPSE in otherwise healthy subjects as they age. Pulsed tissue–derived measurements of right ventricular systolic function have confirmed these findings, agreeing with findings of older studies demonstrating reduced systolic function on echocardiography. The mechanism for this reduction is believed to be secondary to a gradual age-related increase in pulmonary arterial vascular resistance, clinically evident by increased pulmonary artery systolic pressures.[2] This results in the exertion of more ventricular contractile effort into inefficient rotational motions, which has been observed using cine MRI.[3] Inefficient rotational motions and nonlongitudinal muscular movement contribute to the age-related decrease in right heart systolic function.

The aging process also affects right heart diastolic function. Diastolic functional properties can be characterized by determining right atrial pressure, tricuspid inflow velocity, myocardial early diastolic velocity (Ea), and atrial peak velocity (Aa).[4,5] Age is significantly correlated with progressive increases in Aa and decreases in Ea. Additionally, there is a negative relationship between the Ea to Aa ratio and increasing age, indicating less filling velocities in the ventricle despite higher atrial velocities.[4,5] In the same way that systolic functional decline is attributed to increasing stiffness of the pulmonary vasculature, diastolic functional changes are attributed to increased right heart afterload.[4]

Table 1
Summary of the effect of aging on the cardiovascular system

Cardiovascular Element	Alteration in the Elderly
Right ventricle	Reduced systolic function Reduced diastolic function
Left ventricle	Left ventricular hypertrophy Dependence on atrial contribution Age-related impaired contractility and relaxation
Vascular structures	Increased arterial stiffness Systolic hypertension
Cardiac output	Preserved resting cardiac output Preserved ejection fraction
Changes in physiology	Blunted baroreceptor reflex Decreased adrenergic responsiveness
Response to stress	Decreased reliance on heart rate Increased cardiac output due to increased stroke volume