The Effects of Aging on Lung Structure and Function

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KEYWORDS

• Aging • Lung structure • Lung function • Respiratory mechanics • Gas exchange

KEY POINTS

- The aging process alters the intrinsic structure of the lung as well as of the supportive extrapulmonary structures (ie, chest wall, spine, and respiratory muscles).
- These structural changes lead to unfavorable respiratory mechanics associated with decreased expiratory flows, increased air trapping and closing volume, and decreased gas exchange.
- The changes in lung structure and resting lung function impact exercise physiology in the elderly.
- Lung function testing in the elderly is generally a helpful tool but involves consideration of practical limitations and application of appropriate interpretation strategies.
- Normal aging physiology may synergize with the pathophysiology of certain lung diseases to worsen lung function and disease manifestations in geriatric patients.

INTRODUCTION

There are now more Americans older than 65 years than at any other point in US history, and the aging population is expected to increase rapidly over the next decade.[1] Aging influences all aspects of human biology and has characteristic effects on lung structure and function. As with other aspects of human biology, there is heterogeneity of the aging lung with great variability in chronologic, physiologic change among individuals.[2] The main purpose of this article is to review the alterations in lung structure and function that occur with aging in the absence of lung disease. However, insight into these changes in the healthy elderly individual (defined as an individual older than 65 years) can be applied to increase understanding of the manifestations of lung disease in geriatric patients. Whether such knowledge can impact the treatment or treatment response in geriatric lung disease is not currently known.

No disclosures.
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Clin Geriatr Med 33 (2017) 447–457
http://dx.doi.org/10.1016/j.cger.2017.06.001
geriatric.theclinics.com

STRUCTURAL CHANGES IN LUNG ARCHITECTURE ASSOCIATED WITH AGING

With aging, there are changes in the collagen fiber network that provides support for alveolar structure. These collagen fibers coil around the alveolar ducts and adjacent alveoli and prevent them from collapsing during inflation and deflation of the lung.[3] Alterations in the network of collagen fibers with aging lead to alveolar duct dilation and homogeneous enlargement of alveolar air spaces[3–7] (**Fig. 1**). It is important to distinguish these findings in the senile lung from emphysema. In the latter condition, there is associated inflammation and alveolar wall destruction.[5]

Another important factor that helps to stabilize the alveoli is the production of a substance called surfactant by cells that line the alveoli. Surfactant reduces the surface tension within the alveoli, counteracting their tendency to collapse.[8,9] There is no evidence that the properties of surfactant change with aging.[10] Surface tension is inversely related to alveolar size. Thus, a consequence of alveolar enlargement in the elderly is a reduction in alveolar surface tension leading to a more compliant or distensible lung.

EXTRAPULMONARY STRUCTURAL CHANGES ASSOCIATED WITH AGING

Thoracic shape changes with normal aging with a tendency toward kyphosis due to loss of vertebral body height and even collapse of vertebral bodies.[3,11] There is also increased convexity of the sternum; together, these structural changes result in a greater anteroposterior diameter of the thorax.[3] Chest wall compliance decreases because of the spinal changes, stiffening of the rib cage, and reduced thickness of the parietal (ie, chest wall) muscles.[3,5,7,12,13] In addition, the modifications in the chest wall result in decreased curvature of the diaphragm.[13–15] Finally, there is a loss of respiratory muscle mass. Collectively, these changes place the older individual at a disadvantage in terms of the normal mechanics of breathing. **Box 1** summarizes the structural changes that occur in the respiratory system with aging. These changes are often interrelated with compounded effects.

AGE-RELATED CHANGES IN RESPIRATORY MECHANICS IMPACT EXPIRATORY FLOW AND LUNG VOLUMES

Changes in respiratory mechanics lead to predictable alterations in lung function (**Fig. 2**). A more compliant lung has decreased elastic recoil pressure (ie, the deflation

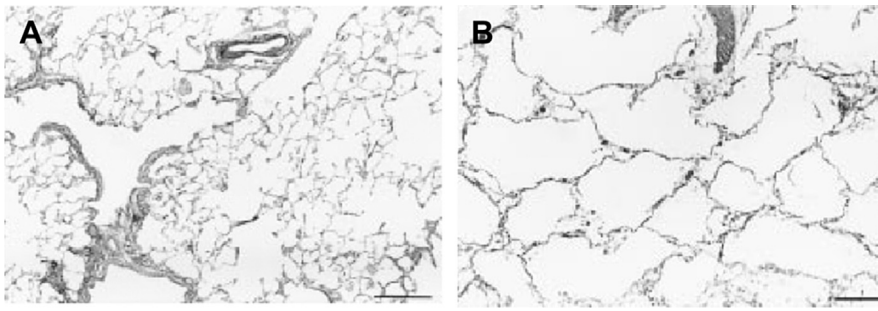

Fig. 1. Lung parenchyma from a 29-year-old nonsmoker (*A*) compared with that of a 100-year-old nonsmoker (*B*). Note the presence of alveolar dilation in the elderly subject. (*Adapted from* Janssens JP, Pache JC, Nicod LP. Physiological changes in respiratory function associated with ageing. Eur Respir J 1999;13:197–205; with permission.)