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Key Points

- Atherosclerosis, or plaque formation in the arteries, is a common disease in many avian species.
- No definitive method of diagnosing atherosclerosis antemortem in birds currently exists.
- Atherosclerosis is now believed to be due to prolonged chronic inflammation rather than solely too much dietary cholesterol and/or fat.
- Omega-3 fatty acids are less inflammatory than omega-6 fatty acids.
- Omega-3 fatty acids also have antibacterial, antifungal, and antiviral properties to aid in disease prevention.

What is atherosclerosis?

Atherosclerosis is characterized by fibrous plaques between the tunica intima and the internal elastic lamina of the vasculature. The heart, great vessels, and peripheral vessels of all sizes can be affected. Atherosclerosis begins with the formation of fatty streaks, which can eventually progress into fibrous plaques and complicated lesions. Plaques are accumulations of lipids, cholesterol, foam cells, macrophages, and other leukocytes. Severe atherosclerosis results in plaques that disturb the vessel lumen while decreasing the diameter of the vessel core and increasing vessel wall thickness. Mineralization of the artery can also occur in severe cases.

Atherosclerosis is now believed to be an inflammatory disease, resulting after a long period of chronic inflammation. Thus the type of dietary fat eaten likely affects the development of atherosclerosis to a greater extent than the total amount of fat consumed. Because diets excessive in either total fat or cholesterol could still cause a stress response and inflammation, fat content must still be considered in the progression of atherosclerosis.

Atherosclerosis cannot always be identified grossly at necropsy since plaque formation begins in the layer between the vessel lumen and the vessel wall. Though in cases where plaques are not seen grossly at necropsy, atherosclerosis would not be considered the sole cause of death.

↑ **top**

Atherosclerosis and avian species

The known incidence of atherosclerosis in birds has a wide range and varies by species. Bird orders known to develop atherosclerosis include Anseriformes (waterfowl), Columbiformes (pigeons and doves), Galliformes (chickens, turkeys, and related birds), and Psittaciformes or parrots. Psittacine birds most commonly affected include Amazona spp., especially blue fronted amazons (*Amazona aestiva*), African Grey parrots (*Psittacus erithacus*), cockatoos, Monk or Quaker parrots (*Myiopsitta monarchus*), and macaws. Parrots displaying grossly visible plaques at necropsy in retrospective studies range from 2% to 25%. Variation within and between species may be due in part to housing and dietary management, genetics, age, and environment.

The primary location of plaque formation varies by bird species. Turkeys tend to develop atherosclerosis in the muscular abdominal aorta rather than the elastic thoracic portion of the aorta. Penguins tend to develop atherosclerotic plaques along the aorta to the renal arteries. Parrots do not normally develop plaques in the descending aorta, but the central portion of the systemic circulation, especially the thoracic aorta and the brachiocephalic arteries, is a common site for plaque formation.

Some conditions are believed to predispose a bird to developing atherosclerosis and include hyperlipidemia, inappropriate long-term diet (especially high cholesterol intake), and lack of exercise. Endothelial inflammation and immune complex disease may also contribute to the development of atherosclerosis.

Plasma risk factors (biochemical markers) are the most common tool utilized to determine the likelihood of an animal having or developing atherosclerosis. These risk factors include high total plasma cholesterol concentrations, high VLDL (very-low-density lipoprotein), high LDL (low-density lipoprotein), and low HDL (high-density lipoprotein). A linear relationship exists between plasma cholesterol level and atherosclerosis. Total vascular collagen has not been proven to be a good indicator of the presence of atherosclerosis in animals.

The most common clinical sign for birds with atherosclerosis is sudden death, however a small percentage of birds display clinical signs consistent with circulatory problems. Clinical signs can include lethargy, dyspnea, fainting or sudden falling, and nervous symptoms due to blood loss in areas of the body.

↑ **top**

Why omega-3 fatty acids?

Omega-3 fatty acids include alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) along with intermediary fatty acids. ALA is found in large proportions in flaxseed, camelina, rapeseed, chia seed, and walnuts. The major source of EPA and DHA is fatty fish. Unlike humans, chickens can efficiently convert ALA into EPA and DHA. Most beneficial health effects regarding atherosclerosis have been contributed to EPA and DHA, though some benefits may result from ALA and other omega-3 fatty acid intermediates.

Increasing the amount of omega-3 fatty acids with respect to omega-6 fatty acids results in a shift in both plasma and platelet fatty acid profiles. When arachidonic acid (AA) is replaced with EPA this limits the amount of AA that can be incorporated into cell membranes or elongated to eicosanoids, which cause an inflammatory response. Therefore, EPA can reduce the risk of atherosclerosis.

Feeding diets with a high proportion of omega-3 fatty acids has been shown to increase antibody response when chickens were given Newcastle Disease vaccinations. Flaxseed has recently been shown to display a chemosuppresive characteristic against ovarian cancer in laying hens. Long term feeding of a diet containing 10% flaxseed reduces mortality rate in commercial laying chickens. The flaxseed diet also improves the ability of birds to maintain their body weight. The amount of ALA in the muscle of birds is negatively associated with the degree of atherosclerosis.

The effect of ALA on plasma cholesterol and triglyceride levels is still debated, however other biological changes may prove to be more important than overall plasma cholesterol levels. Most species of birds can benefit from the addition of an ALA source in the diet. A source of EPA and DHA is recommended for carnivorous avian species as their ability to convert ALA to EPA and DHA is unknown.