

## **The Cardiovascular System and the Eyes, Part I: What is their relationship?**

*by Louis Catania, O.D., F.A.A.O. and Ernst Nicolitz, M.D., F.A.C.S.*

Summary: The aging process on the heart and blood vessels (the cardiovascular system) is of great significance in health care. But why would we address it in a column about eyes and vision? The reason is quite simple. Maintaining proper functioning of our eyes is very dependent upon the health of our cardiovascular system. Part I of this 3 part series on the cardiovascular system and the eyes will define how the 2 systems interrelate.

The subject of the aging process on the heart and blood vessels (the cardiovascular system) is of great significance in health care. But why would we address it in a column about eyes and vision? The reason is quite simple. Maintaining proper functioning of our eyes is very dependent upon the health of our cardiovascular system.

It's not too hard to understand the profound effects the cardiovascular system has on the eyes when you look at the basic anatomy of the heart and its major blood vessels and their relationship to the eyes. Such an understanding also helps you recognize why the eyes are so valuable in diagnosing cardiovascular problems.

The main artery from the heart is called the aorta which arches off the heart in an upward direction (see diagram). Two of the main branches coming off the aortic arch which supply the structures of the head and the brain are called the external carotid arteries. The left carotid artery comes directly off the aortic arch and the right carotid branches from another main artery (subclavian) coming off the arch. The external carotid arteries subdivide to internal carotid arteries and these give off major divisions called the ophthalmic arteries which supply all of the blood vessels to the external and internal structures of the eyes.

As we said previously, by understanding this basic anatomy of the cardiovascular system you can quickly see the intimate relationship between the eyes and the heart. Also remembering that we can look inside the eyes through the pupils, the eyes become a great place to directly see the health of a person's blood vessels and, indirectly interpret the condition and functioning of the heart as well.

Thus, the connections between the heart, the blood vessels and the eyes become an interesting and complex relationship. On the one hand, all the parts of the eye are benefited by the nutrition and oxygen supplied to them through the blood vessels. Thus, the eyes are also vulnerable to the problems of aging that can so significantly affect the heart and blood vessels (more about this in Part III of this discussion).

On the other hand, the eyes serve as a wonderful diagnostic tool for us as eye doctors as well as your family medical doctor, internist or heart specialist to use to evaluate the health and function of your cardiovascular system. Examination of the eyes allow all of us to identify,

monitor and manage many of the cardiovascular problems people suffer from, especially those in aging that threaten your health, well-being and even life itself.

Our next column (Part II) will discuss the major cardiovascular conditions that can occur during aging and how we can identify and diagnose them through examination of the eyes. These conditions include hypertension or high blood pressure, arteriosclerosis or hardening of the arteries and atherosclerotic disease or plaque formations in the blood vessel.

## **The Cardiovascular System and the Eyes, Part II: Conditions seen in the eye**

*by Louis Catania, O.D., F.A.A.O. and Ernst Nicolitz, M.D., F.A.C.S.*

Summary: The poets say “the eyes are the window to the soul.” Health professionals also see them as “the window to the body.” In no area is that “window” more valuable than cardiovascular care, especially in aging. Let’s see how valuable it really is.

The eye allows us a unique, non-invasive view of the cardiovascular system in its live action, in living color (as they say on TV!). No where else in the body can we see blood vessels and the blood itself in active, real-time circulation. This capability provides one of the best diagnostic tools for evaluating conditions of the blood vessels (arteries and veins), the blood itself (blood cells and the serum or fluid portion of the blood) and indirectly, how the heart is working.

Three of the most common cardiovascular conditions associated with aging become dramatically visible and measurable through examination of the retinal blood vessels inside the eye. As described in Part I (last column) of this discussion, these retinal vessels are branches from the ophthalmic arteries, which branched from the carotid arteries, which came off the aorta of the heart. Thus, these retinal vessels in the eye reflect the condition and function of their parent vessels and ultimately the condition and function of the heart itself.

The first cardiovascular condition readily diagnosed through the vessels of the eye is hypertension or high blood pressure. This increased pressure in the blood vessels produces visible changes in the caliber (narrowing), tortuosity and crossings of the retinal arteries and veins. Comparing these changes to the normal appearances of retinal blood vessels allows us to directly measure the increased pressure effects and indirectly, it gives us the ability to assess how the heart is working. This assessment combined with information from other diagnostic tests like blood pressure readings, heart sounds, etc. enables us to make decisions as to the degree of the problem and communicate with the patient’s physician who will determine how best to control the pressure through medications, diet, stress reduction, etc..

Another cardiovascular condition that is observable directly through examination of the retinal vessels is arteriosclerosis or hardening of the arteries. Again, the difference from normal vessel appearance varies due to thickening of the blood vessel walls creating changes in vessel

size, shape and coloration. This provides invaluable information that suggests the need for further testing, monitoring and cardiovascular treatment approaches to protect against serious risks that are known to be associated with hardening of the arteries.

Yet another serious cardiovascular condition observable in the vessels of the eye is atherosclerotic disease. This is a relatively common condition in aging often associated with hypertension and arteriosclerosis. The condition is a product of too much fat or cholesterol in the blood causing plaques or clots to form which then attach to the inside of the blood vessels' walls (thrombus) further narrowing their openings or breaking loose and traveling through the bloodstream (emboli).

This latter situation is very dangerous because sometimes the traveling emboli can't pass through a narrowed vessel (narrowed by a plaque or some other cause like arteriosclerosis) causing a blockage of the vessel which starves the tissue downstream of its nutrition and oxygen. This produces loss of function of the starved tissues and is called a "transient ischemic attack" or TIA. If this starvation of tissue goes on for too long or effects vital brain centers, it is called a stroke.

Because retinal vessels are narrower than the carotid arteries, often times a clot will travel successfully through the carotid only to get lodged in a retinal vessel. Spotting these vessel changes and clots in the arteries of the eye tell us that these thrombi and emboli are forming in and breaking off the carotid arteries' walls as well as in the arteries elsewhere in the body. Often times, when we see or have a concern about emboli or even abnormal appearance of retinal vessels, eye doctors may use a stethoscope over your neck to listen for irregular blood flow (called bruits) in the carotid arteries. This test is very valuable and may result in further blood flow studies or a referral to your physician for further cardiovascular evaluation.

Also of great concern upon identifying emboli in the retinal vessels is their possible formation in the vessels of the heart (coronary vessels) as well. These clots present a serious risk for potential and fatal heart attacks (myocardial infarction). Certainly in these cases, immediate cardiovascular care is required and the patient's eye care may have proven to be life-saving.

## **The Cardiovascular System and the Eyes, Part III: Effects on the eyes and vision**

**by Louis Catania, O.D., F.A.A.O. and Ernst Nicolitz, M.D., F.A.C.S.**

Summary: Problems with our cardiovascular system lead to problems with most other organ systems in the body due to compromises in circulation, nutrition and tissue health. But the eyes are particularly vulnerable to compromises in cardiovascular health. It's worth understanding the relationship to better protect your eyes and vision.

Our last column (Part II) considered the diagnostic value the vessels of the eyes provide in major cardiovascular conditions including hypertension, arteriosclerosis and atherosclerotic

disease. Now let's take a look at the effects those same conditions can have on the eyes and vision.

Hypertension and arteriosclerosis change the size and caliber of retinal blood vessels (and of course, the ophthalmic and carotid arteries) and thus, alter blood flow through the arteries and to the tissue they supply. Besides loss of adequate blood flow through the arteries (ischemia) to the tissues as we described in Part II (last column), changes in the veins which drain the blood from tissue, can also cause problems. Too much compromise in the veins can lead to tissue congestion, leakage of the vessels and even hemorrhaging.

These problems in circulation can lead to numerous tissue complications in the eye as well, including fluid buildup in the tissues (edema), exudates (deposits from the blood) and hemorrhaging inside or on the surface of the eye. Any of these changes are a threat to vision if they become severe or if they directly affect the sensitive layers of the retina that control our sight.

Also, atherosclerotic disease can have numerous effects on the tissues of the eye and on vision. Because atherosclerosis is caused by too much fat and cholesterol in the blood, these adverse substances can escape from the blood and deposit in the tissues of the eye. On the retina, they can produce fatty deposits in the macula region (the most critical tissue for central vision) leading to macula degeneration (see the Nov. 11<sup>th</sup> and 25<sup>th</sup>, 2002 columns) and this can lead to blindness.

The fats and cholesterols that produce the clots we spoke about in Part II (last column) can also escape into the cornea and eyelid tissue producing cosmetically apparent changes in the appearance of those tissues and structures. They can produce yellowing, swelling and irregular lumps and bumps on the surfaces of the eyes and the eyelids.

Another risk of clots in atherosclerotic disease occurs in the ophthalmic arteries. Some of the blood vessels branching off the ophthalmic arteries supply the muscles that control movement of the eyes and eyelids. If a clot were to block any of these arteries, those muscles would lose their oxygen supply and would no longer be able to function. This would result in sudden onset of double vision, crossing eyes or a drooping eyelid.

And finally, the ophthalmic arteries also provide circulation and oxygen to the optic nerve. This is the main nerve supply from the eye to the brain which transmits light impulses from the retina to produce vision. If a clot were to block an ophthalmic artery and reduce or eliminate circulation to the optic nerve, the eye would quickly lose complete vision. This is negative course of events is called "amaurosis fugax" or an "ocular stroke." The visual effect of this kind of blockage is a classic appearance of "a shade coming down over the vision." Such a visual effect must be considered a major risk to both vision and to life itself.

From this discussion and from the past 3 columns on the relationships between the cardiovascular system and the eyes, it should be quite apparent that there is indeed an intimate

relationship between the cardiovascular system, our eyes and aging. So, take care of your heart and blood vessels with proper health habits, good diet, exercise, stress reduction and regular medical and eye care and you'll feel better, see better...and probably live longer!