Aging - Involution or Degeneration?

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"Every man desires to live long, but no man would be old."

Jonathan Swift.

In 1800, the expected life span was eighteen years; compared to the present day, the world was in a primitive state. Nevertheless, at that time, Thomas Malthus presented his theory of diminishing returns, noting that the population was expanding in a geometric progression, and that soon there would not be enough food or space for the world population. Malthus emphasized that this expansion of population was kept under control by various natural mechanisms, one being the high death rate in infancy and adolescence. It is now apparent that the span of life is not increased by environmental factors, and that these factors function only in a negative way, ending life prematurely. By attacking the environmental influences that so devastingly shortened life in 1800, modern medicine has shown that man is capable, constitutionally, of surviving many decades. However, it is important to note, that despite the outlook for further progress in medicine, the fact that scientific medicine reduces the death rate is not of vital importance in terms of a long range population trend. Once the death rate prior to the age of fifty (the reproductive years), is brought to very low levels, there is little room for improvement and keeping old people alive longer has only temporary effects on population trends. [1]

In any discussion of aging almost as much importance attaches to the age of the observer as to the age of the individual observed. For example, to a child of ten a man of thirty is "old"; to a person who is seventy, this man is still young. One might say that aging is a process that begins with the union of sperm and egg and progresses until death. In the years of infancy and childhood, this process is readily apparent as being anabolic. The years between biological maturity and the gross recognition of the onset of aging are a latent period, with no major detectable morphological changes. Undoubtedly, there are distinct changes occurring at this time, however they are not readily apparent. In fact, it is better to consider those years at the end of reproductive life (approximately 50) as a time of initial appearance of 'aging' which progresses by gradual transition to 'old age', both on a morphological and a functional basis. Any congenital or acquired diseases which lead to extreme premature physiological aging must be excluded from this discussion.

Even in young patients at times it may be somewhat difficult to make a distinction between normal variations and a pathological condition. In the field of geriatrics the problem becomes magnified, particularly in drawing any hard and fast distinction between physiological atrophy and degenerative disease, if indeed any true distinction exists. The distinction between the physiological and the pathological features of aging is a rather nebulous one. From a physiological point of view, there is a pattern of systemic organ changes. Only after these have been considered can one study specific pathological processes.

GENERAL PHYSIOLOGICAL CHANGES

With advancing age there occurs an increasing amount of stroma relative to parenchyma. Detriments in function begin in any 'healthy' person about age thirty-five, and thereafter there is a steady downhill trend. The basal metabolism decreases progressively, not per functional unit, but because there is an actual decrease in the amount of tissue. Cells die, are removed, and are not replaced. "The 80-year-old has less tissue to be supported that does the 30-year old." [2]

Cells themselves, the building blocks of the body, undergo changes with age:

1) They contain more solids and less water because colloidal material (protoplasm) loses water with age. There is a shift of fluid from intra- to extra--cellular spaces, resulting in "senescent edema".

2) Lipids and pigments accumulate.

3) Mitochondria are altered to a less elongated, more granular form.

4) Calcium accumulates in the cell membrane reducing its permeability.

Homeostatic mechanisms are impaired, the physiological resiliency of youth is lost, and there is increased susceptibility to deleterious stimuli.

Inflammations—Older people are apparently more prone to infections; due to recent progress in the control and treatment of infectious disease, there has been a marked increase in the number of old people.

Malformations—Due to systemic physiological alterations, the old are more susceptable to ill effects from any trauma, especially in relation to bone injuries.

Neoplasms—Statistically, it is noticed that this age group presents most often with neoplasms of practically any organ or tissue. In some cases, this can be explained by the insidious growth and the time necessary for the neoplasm to present clinically.

ORGAN CHANGES

Each organ, with the exception of the blood constituents, has its own pattern of atrophy; the latter remain practically unaltered into old age if no underlying organ pathology is present.

SKIN

Senile changes in skin have been observed in unexposed parts of the body as distinguished from those changes which occur in the parts exposed to sunlight and weather. The loss of elasticity, diminished sweat secretion, and fragility of small blood vessels result in increased susceptibility of the skin to injury. These changes plus the loss of subcutaneous fat cause the skin to appear dry, wrinkled, and shiny, with many folds. Histologically, the dermal papillae atrophy or flatten, the dermal ground substance decreases while collagen and basement membrane material increase.

The water containing capacity of the skin is lost, and sebaceous glands involute, due to change in hormonal factors. The supporting connective tissue degenerates, and the small blood vessels become more fragile, less able to respond to heat and cold. Another related change is the increased difusability of senile skin, which allows infection to spread more rapidly—a dangerous situation in an elderly individual, whose normal physiological defenses may already be weakened.

HORMONES

Widespread changes in function occur in most hormone-producing organs, whether accompanied or not by alterations in morphology.

Thyroid—There are fewer follicles, and those that remain are empty or contain only a small amount of colloid; therefore, the effective amount of thyroxine is decreased.

Pituitary, Pancreas, Adrenal—There is a change in function manifested by altered hormone levels, but morphological changes are more subtle, and cannot be detected.

Ovary and Testis—The sex hormones are diminished greatly—in the female, sharply at the menopause; whereas, in the male, this decrease is more gradual. In addition to their more obvious effect in maintaining the function of the sex organs, these hormones have other important functions—they play an important role in protein synthesis and degradation; estrogen increases the clotting power of blood, and is involved in fat metabolism (this is made apparent by the fact that in females after menopause, deposition of atheromatous plaques increases markedly).

Often, senescence is blamed on the decreased production of these hormones, or alternately, on the reflex increase of the pituitary gonadotrophin. It might be thought that administration of these hormones could delay aging, but the expected effect is often diminished or absent, because the target organs themselves lose the capacity to respond.

UROGENITAL TRACT

Urinary—"The ability of the kidney to excrete is only about half as great in a 90-year-old as in a 30-year-old."[3] This merely represents a specific example of the general atrophy of age. Some nephrons disappear, and those that remain are damaged, with concomitant alteration in function. In addition, the urological diseases seen in any age may be present and the reserve capacity is low.

Genital—Female—Atrophy of the genital organs is accentuated markedly at the menopause. The ovary, begins its atrophy quite early, and at autopsy in an aged female, a strip of fibrous connective tissue might represent the entire remains of the ovary. Changes in the uterus, vagina, and breast, other than generalized atrophy, are related to a definite hormonal factor. For example, since estrogen which normally maintains the uterine endomentrium and the ductal stroma of the breast is markedly diminished, as might be expected, corresponding trophic changes occur in these organs.

Genital—Male—Structures persist in the male much longer—the testis, as opposed to the ovary, atrophies much later in life. Some clinical problems are—prostatic hypertrophy, scrotal masses, such as hydrocoele and hernias, and the occurance of neoplasm anywhere along the urogenital tract.

SEX DRIVE IN THE AGED

This depends on the previous status of the individual. If the sex drive was strong in youth, it is usually moderate in old age; if weak in youth, it is usually absent in old age. Other factors are involved, such as marital status or the individual, or chronic illness, which puts a definite end to sexual activities.

Many misconceptions exist about sex in old age; to most people the idea is abhorrent. The potency in the male need not dwindle with age, just as the capacity of the female to enjoy sex does not disappear abruptly at the onset of the menopause.

CARDIOVASULAR

The most striking vascular alteration is atherosclerosis, which is a continual process, and is usually manifested in old age by vascular insufficiency—for example, limb pain on exercise, anginal pain, and CNS symptoms. A great danger lies in "little strokes" [4] which result in increasing confusion and mental deterioration. Chronic headaches may result from such conditions as temporal arteritis, and hypertensive encephalopathy. The blood pressure slowly increases due to loss of elasticity and sclerotic changes in the vessels.

The heart itself undergoes so called "brown atrophy" or may become larger or heavier, compensating for the greater work load required to push the blood through narrowed arterioles. There is an increase in fat and fibrous tissue, and the regulation of the heart beat is less efficient, resulting in premature contractions and auricular fibrillations.

GASTROINTESTINAL TRACT

Changes are not easily demonstrable here, except that the stomach secretes less HCi, and the liver shrinks — a change probably interrelated with body atrophy. "... the digestive organs lose their functional ability if not kept in function."[5] Constipation is of widespread incidence in the aged; this is thought to be a part of the normal aging process, but morphological changes to explain its onset cannot be isolated. Its significance, and possible pathological sequelae cannot be neglected but should not be over stressed.

NUTRITION

No evidence exists that nutritional requirements of elderly individuals are any different from any adult. Emaciation of the aged, more noticeable in physically inactive persons, occurs primarily for three reasons: :

1) Loss of appetite because taste and smell receptors degenerate.

2) Loss of teeth, making chewing difficult.

3) Inadequate physical activity, resulting in loss of appetite.

It follows that if nutrition is inadequate, there is poor protein, mineral and vitamin intake, and the individual is predisposed to illness, such as, osteoporosis, beri beri heart disease, and possibly deficiency anemia. Because of this poor intake, it is often difficult to asses whether changes are due to nutritional deficiencies, or are merely a future indication of aging. [6]

CENTRAL NERVOUS SYSTEM

There is a decrease in the number of neurons, and general responses are slowed. Often, apparent physical and psychological phenomena are entirely unrelated to the morphological condition of the brain. Indirect effects from "little strokes" and ischemia may be responsible for senile changes.

So far, medical science has not been able to prevent these changes, and even though we must search for mechanisms and causes, we can never hope to prevent them completely. This goal will never be achieved, and just as Ponce de Leon was disappointed in his search for the "fountain of youth" so will be the scientists who attempts to maintain an individual's life for eternity.

"The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labour and sorrow; for it is soon cut off, and we fly away." [7]

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