Ageing and Flying Fitness

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Introduction

It is well known that Physiological age does not correspond to the chronological age. While the onset of menopause is a definite landmark of old age in women, there is no such landmark in men. The term old age, therefore, is a very relative one and can be defined only arbitrarily. In this paper it is intended to assess the influence of ageing on the flying performance of an individual with an endeavour to bring out the changes in physiological functions apparent in the age groups between 20 and 40 years—the age at which operational (military) flying is normally done.

Flying duties are more exacting than other youthful activities, because while the latter may land an old man in hospital with a stiff back or a wry neck, former may prove fatal to an individual when faced with an emergency because of his slow reactions, poor reflexes, slow thinking and inadequate coordination. When we talk in terms of ageing in a pilot, we have to keep in mind his ability to respond to emergency situations with a speed fast enough to deal with them and come out of the situations alive without damage to life and property. The day this capacity is impaired a pilot may be considered too old for flying duties although he may possess a better stamina than a younger man in a game of squash or hockey.

Physiological changes in old age

There is a gradual loss of cells as the individual ages[5]. This decrease in metabolically active cells is paralleled by a decrease in body proteins and intracellular water[1]. The total body mass is unchanged since the increased fat matches the decrease in cell mass. The changes therefore are quantitatively related to the reducing number of functional cells e.g. reduced oxygen uptake and hence reduced circulatory demands. This leads to a reduced functional efficiency one of the manifestations being prolonged neural conduction time, a factor which is responsible for a delay in perception of an emergency by a pilot and a prolonged reaction time.

Cardiovascular system shows well established physiological changes. Cardiac output starts decreasing from the age of 25 years[3]. This is because of a greater reduction in stroke volume than the heart rate. Under a work stress, the resultant tachycardia is not as great as in youth. Cardiac output is therefore reduced significantly and is responsible for breathlessness of a higher degree. The time required for contraction of heart is prolonged. This is responsible for increased energy expenditure and oxygen requirement[6]. Thus, for a given amount of work done, cardiac power is less and energy expenditure is more than in young people. During exercise, stroke volume is increased and partly compensates for the individuals inability to maximally accelerate the heart rate. Cardiac output increases and produces a rise in arterial pressure. Resting arteriovenous oxygen difference increases as the tissues consumes greater amount of oxygen. This increase, however, is less marked in older age. There is thus a greater oxygen debt which is the cause of prolonged tachycardia. Ageing arteries show progressive chemical and anatomical changes. Their resiliency diminishes with age independent of the atherosclerotic changes. Because of the loss of elasticity, the intra-aortic systolic pressure rises more abruptly as an increasing amount of blood is forced into the vessel. There is a reduction of blood flow to various organs with a complete redistribution i.e. the reduction in blood flow to various organs is not symmetrical. Bender[2] has estimated that the flow to coronaries and cerebral vessels is dispro-

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portionately less than the reduction in cardiac output would warrant. This aspect assumes special importance in an aircrew exposed to mild degrees of hypoxia and frequent shifts of blood columns when under "G" stress. Peripheral resistance increases out of proportion to changes in cardiac output and the residual metabolic activity. This increase in total peripheral resistance is responsible for elevation of diastolic pressure also.

There is also a reduction in compliance of chest wall and in the force of expiratory muscles[4]. There is a decrease in the amount of pulmonary tissue which is responsible for a decrease in the number of alveoli which increase in size in an attempt to fill the pulmonary cavities. There is also a dilatation of bronchioles and alveolar ducts. The ageing lung becomes increasingly rigid. Maximum Breathing Capacity (MBC) decreases and so does the Forced Expiratory Volume (FEV). Functional Residual Capacity (FRC) increases. These are some of the other factors which limit the compensation brought about by hypoxic and other stresses. Increased FRC is responsible for the delay in oxygenation of blood when 100% oxygen is breathed during hypoxic stress. Notwithstanding these changes, maximal amount of oxygen consumed under stress is reduced either because the stressed tissues are not perfused or because the tissue utilization of oxygen is reduced secondary to reduction in the cellular mass brought about by ageing.

Renal mass also is reduced as the age advances because of reduction in the number of glomeruli. Ogden[7] has reported that the compensatory hypertrophy reduces with age. Since the ultimate Kidney function is related to the actual mass of Kidneys, this observation is important since it hampers the tubule cell function like reabsorption of glucose and water. Glomerular Filtration Rate (GFR) also decreases. There is, however, a greater reduction in renal blood flow and hence the filtration fraction $\frac{GFR}{\text{Renal Blood Flow}}$ increases.

Ageing is responsible for a reduction in response to glucose either because of a reduced insulin secretion or because of a reduced peripheral sensitivity to the released insulin. There is a progressive neuronal loss with a progressive decrease in the weight of brain. Cerebral blood flow also decreases with an increase in cerebral vascular resistance and a drop i cerebral oxygen consumption. All these factors ar responsible for a decrease in nerve conductio velocity. Visual functions decrease with old ag principally as a result of cumulative damage to th transparent portions of ocular system. Visual field get restricted so do the speed of dark adaptation an the minimum threshold of light perception. Th importance of these changes in an aircrew needs n elaboration.

Most important and meaningful changes occu in the psychological sphere. As age advances, on becomes more and more vulnerable to the effects o stress. One may be able to perform a task as fas and as well as a younger man but may not be able t respond as well during stress. This is because of th element of stress added here e.g. an aged person manifests poor learning ability when forced to learn within a specified time but when the stress of thi time factor is removed, he will be able to complete the learning task. He does not therefore become intellectually impaired but becomes more vulnerable to stress. Any situation which is associated with stress factor cannot therefore be adequately met. One may not hesitate in making a sweeping statement here that older the pilot less competent will he be as an operational pilot.

Briefly described above are the changes which are associated with ageing. The actual age at which these changes occur varies in different individuals and cannot therefore be defined. Changes occur gradually over a period of years and may not be discernible to a casual observer. To what extent are these changes hastened or modified by various stresses encountered in flying is not known. Operational flying is undertaken either at very high altitudes to get a better performance from the aircraft or at tree top heights for operational reasons. Could the repeated exposures to hypoxia of high altitude or vibrations experienced at tree top heights influence the normal physiological process of ageing? Other aircrew may be required to breathe 100% oxygen during flying for varying period in a day and for days together at a stretch. It is well known that prolonged exposure to 100% oxygen is likely to lead to disturbances in pulmonary functions. It is not, however, known how repeated exposures to subtoxic doses of oxygen affect these functions. An aircrew is also exposed to decompressions of varying degrees during routine flying. For various reasons, the altitude in a pressurised cabin has to be maintained at as high a level as is physiologically acceptable. By and large, the cabin altitude is maintained around 25000 ft. Even at this altitude and at lesser altitudes cases of decompression sickness, have been reported. In majority of individuals, however, frank manifestations of decompression sickness are rarely seen below this altitude though silent bubbles do form at different places in the body. These bubbles are known to get automatically absorbed over a period of a few hours on descent to ground level. It is not known what long term effects would accompany the repeated formation of bubbles. Acceleration is associated with shifting of long columns of body fluids and varying degrees of circulatory shifts. Vibrations are a common occurrence in low altitude high speed flying and are transmitted from the aircraft to human body affecting various organs. Increased intrapulmonary pressure of a mild degree is another hazard the long term effects of which on pulmonary functions are not known. All these factors produce temporary shifts in physiological functions. Unless these shifts are gross, homeostatic mechanisms come into play and help in restoring these functions. Do these mechanisms continue to be adequate when the body is repeatedly exposed to stresses? It is a likely presumption that they become inadequate with advancing years. It is not, however, known whether they hasten the changes associated with advancing years. It may be possible to answer the question — "What is the influence of ageing on physical performance of aircrew?" but yet there is no answer to the allied question "Upto what age can the aircrew performance be considered optimum?" On the one hand, there is a physiological deterioration brought about by age and possibly by repeated exposure to the various flying stresses. On the other hand, we have the experience and maturity gained by the aircrew with increasing number of flying hours. Upto what extent is the balance maintained and when does it break down is not known.

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