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Dysthyroidia in aircrew: flight safety impairment and aptitude management

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Introduction

Thyroid pathology is very frequent in aeronautics,[1] because of this frequency, it is necessary to objectively define the impact of this disease on flight safety. The impact of dysthyroidism is potential on aeronautical activity, even without being perceived by the pilot, fatigability, memory and concentration problems, are an undeniable danger. The ophtalmological or cardiovascular complications are also involved in flight security. The aim of this paper is to briefly remember the effect of thyroid hormones on cardiovascular system and the cardiovascular modifications related to aeronautical environment then the authorswill define the impact of dys thyroidism on flight safety and finally they will discuss the management of aeronautical fitness in case of an aircrew with dysthyroidism.

Thyroid hormones and cardiovascular disease

Thyroid hormone directly affects heart and vascular system[2] because Myocardial and vascular endothelial tissues have receptors for thyroid hormones and are sensitive to any changes in the concentrations of circulating thyroid hormones.[3] Triiodothyronine (T3) enters the cardiac monocytes, and binds to nuclear T3 receptors. newly formed complex bind to several mechanisms that lead to increase myocardial inotropy and heart rate, dilate peripheral arteries to increase cardiac output. An alternative way of action for thyroid hormone is non nuclear T3 actions on ion channels for sodium (Na^+), potassium (K^+), and calcium (Ca^{2+}) ions, this effect is observed immediately in a few minutes causing fluctuations in ion currents responsible for inotropic and chronotropic positif effect.[4]

The main cardiovascular manifestations encountered during hyperthyroidism are a decrease in peripheral vascular resistance, an increase in blood volume, myocardial contractility, cardiac output and heart rate.[2] They can cause complications such as arrhythmia and excitability disorder (frequent sinus tachycardia and ventricular extrasystoles,atrial flutter is rare and Bouveret tachycardia is exceptional,[3-4] Atrial fibrillation is the most frequent rhythm disorder present in 9 to 22% of cases, compared to 0.4% in general population[5] which predisposes to embolic events particularly in the brain in 15% of cases),[6] angina (that can occur occasionally in subjects with healthy coronaries, myocardial infarction is exceptional in young people, free from underlying heart disease) and heart failure (it occurs in approximately 6% of patients before the age of 50, pathogenesis of heart failure is not fully understood, it seems to result from the conjunction of several factors associating volume load, decreased duration of diastolic filling and contractile myocardial reserve).[5]

Subclinical hyperthyroidism is associated with increased heart rate, ventricular or supraventricular arrhythmias, ventricular extrasystoles are more frequent and atrial fibrillation is not uncommon, increased left ventricular mass impaired ventricular relaxation and reduced exercise performance.[7]

The cardiovascular manifestations of hypothyroidism are the reverse of those observed in hyperthyroidism. They are characterized by a decrease in cardiac output, an increase in peripheral vascular resistance, a normal or slowed heart rate. Clinically pericardial effusion is found in 3 to 6% of cases usually well tolerated,[8] diastolic hypertension found in 15 and 28% in the majority of studies, increases of coronary disease, myocardiopathy and congestive heart failure. Unlike hyperthyroidism, conduction disorders are more common in hypothyroidism than arrhythmia with an extension of the PR space and a right branch block.[2-3] Subclinical hypothyroidism is associated with impaired left ventricular diastolic dysfunction at rest, with systolic dysfunction in case of stress; the risk for atherosclerosis and myocardial infarction is increased.[7]

Cardiovascular modifications related to aeronautical environment

Airspace is an environment characterized by oxygen depletion, decrease in barometric pressure and temperature drop. In addition to these specific environment constraints, there are those related to aircraft operations (acceleration, vibration, soundscapes, heat, lower humidity) and their piloting (stress, fatigue). In this context, the cardiovascular system will essentially be stressed by hypoxia and accelerations.[9]

Acceleration

Any change in the speed vector applied to a body induces acceleration and an inertial force in the opposite direction of the acceleration. In aeronautical operations + Gz accelerations are the most frequent in aviation mainly in fighter aviation, they are radial accelerations applied on the large vessels axis, causing an inertia force directed from the head to the feet (Figure 1). They will increase the gravitationnal component of blood pressure (BP) according to their intensity factor.[9] hydrodynamics disorder resulted from blood maldistribution to the lower part of the body by G load, can produce reduced venous return from the lower half of the body and also reduced blood circulation around central nervous system (CNS) in the cranial cavity.

BP lowering proceeded by heart rhythm decrease and by blood maldistribution to the lower part of the body reduced cardiac outputs and then BP declined.[10] This BP drop is detected by carotidien sinus leads to sympathetic stimulation and parasympathetic inhibition

responsible for an increase in heart rate, an increase in myocardial contractility and a vasoconstriction leading to an increase in arterial pressure which, in part, compensates cerebral hypoperfusion.[9] Sinus tachycardia is a physiological response due to catecholamines secretion induced by accelerations. The occurrence of bradycardia, by sinus brake application, is frequent when the acceleration stops and vagal hypertonia, on an organism then impregnated with catecholamines, can promote supraventricular hyperexcitability.[11] However, during acceleration, bradycardia, sinoauricular blocks or junctional rhythms are sometimes observed. In addition, due to their action on the adrenergic nervous system, accelerations are particularly arrhythmogenic and promote the occurrence of ventricular extrasystoles.

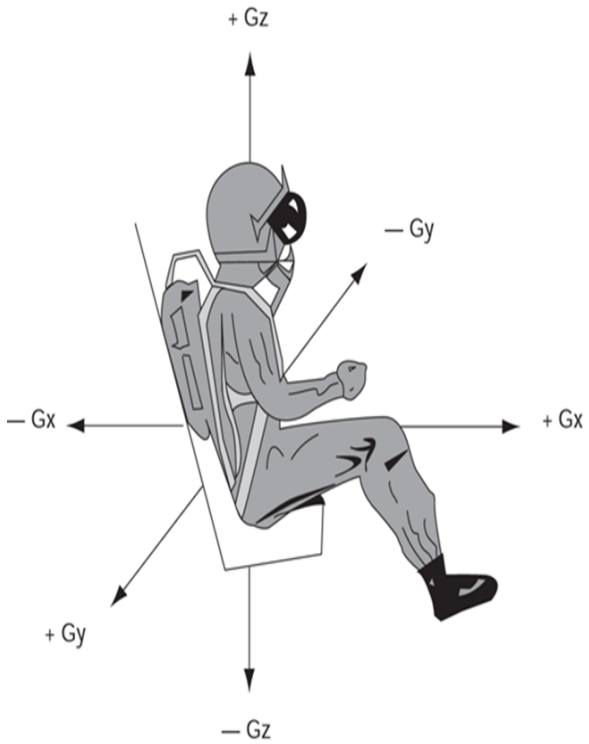

Figure 1 Direction of acceleration according to the body's axis.

Hypoxia

altitude hypoxia has few consequences, causing a moderate rise in heart rate (10% at 3000 meters 15% at 4500 meters) and a slight increase in systolic blood pressure, but can promote decompensation of chronic bronchopathy or coronary artery disease.[12]

Consequenses of dysthyroidism on flight safety

Cardiovascular system is highly sollicited by both thyroïdien hormones and aeronautical environment, the presence of TH abnormality in a pilot can cause clinical consequence that threatens flight security and risks an in flight incapacitation. Hyperthyroidism in a pilot can cause as cited in the top a heart rhythm disorders, palpitations, tachycardia, atrial fibrillation, or other symptoms of hyperthyroidism cardiovascular complications which cause a sudden ou subtile inflight incapacitation. These symptoms can be aggravated or decompensated by aviation constraint. We note that for exemple a simple sinus tachycardia can reduce significantly the accelerations and altitude hypoxia tolerance. The chronotropic and inotropic effects of thyroid hormones increase the myocardium oxygen consumption and can accelerate ischemia with a vascular obstruction in people with healthy coronaries. Onset of angina in flight is a serious problem that causes a total or partial loss of aircraft management.

Management of aptitude in aircrew with dysthyroidism

Pilots and other cabin crew are regularly checked by a physical fitness test in aeromedical expertise center, the otolaryngology system is inspected each visit. Medical history is not contributing in expertise context because the aircrew wants to be fit to fly so he can hide his pathology or his functional signs. Symptoms of hypothyroidism are often unheeded by aircrew or by the flight surgeon, such as a simple fatigue or asthenia that can be related to rhythm of work and jet-lag effect. The clinical presentation of hyperthyroidism remains incomplete in expertise medecine and the systematically electrocardiogram is often contributing to diagnosis showing: sinus tachycardia, supraventicular extrasystole or other abnormalities described above.

European Union Aviation SafetyAgency(EASA) requirements stipulated that an aircrew may be fit after a metabolic, nutritional and endocrine dysfunction if:[13]

a. Asymptomatic.

b. Clinically compensated and stable with or without replacement therapy.

c. Regularly reviewed by specialist.

d. Hyperthyroidism or hypothyroidism should be unfit, a fit assessment may be considered when a Steele euthyroid state is attained.[13]

If dysthyroidism is suspected flight surgeon must confirm the diagnosis, look for the etiology by several investigations, access the treatment efficiency and tolerance and finally evaluate the risk of recurrence.

In case of hypothyroidism a temporary unfitness decision is required for a short time until biological normalization. An exploration of the coronary reserve is necessary in middle aged pilot. once diagnosed treated and stabilized, hypothyroidism does not present any problem of fitness for all aeronautical functions.

Hyperthyroidism primarily due to Basedow disease, it's encountered in cabin crew member, unfitness is the rule for a time which depend of treatment type (Anti-thyroid drugs are used, radioactive iode or surgery). we can consider the fitness after a minimum period of 3months in the absence of any cardiovascular signs or progressive ophthalmopathy. Finally the risk of recurrence or the occurrence of a late hypothyroidism after radioactive iodine involves regular long-term biological monitoring.

Conclusion

Cardiovascular system is highly sollicited by both thyroïdien hormones and aeronautical environment. Flight safety can be engaged in cases of undiagnosed hypothyroidism or active Basedow' disease. The decision to return to flight after hyperthyroidism treatment is sometimes problematic.

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None.

Conflicts of interest

No conflicts of interest.

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