CHAPTER 10 - THE MUSCULOSKELETAL SYSTEM

1 INTRODUCTION

The physical and functional musculoskeletal demands on pilots have changed considerably with the development of modern aircraft; where previously muscular strength was a necessity, the most important ability today is fine motor skills. The musculoskeletal requirements for air crew flying commercial aircraft and that for private pilots are the same (see JAR–FCL 3.200 and 3.320), but should be applied with due regard to the different demands of different categories of aircraft.

The general guidelines of fitness to be adopted when assessing the musculoskeletal system of an applicant are described in this chapter. These include the assessment of:

a Any abnormality of the bones, joints, muscles and tendons, congenital or acquired, which is likely to interfere with the safe exercise of the privileges of the applicable licence.

b Sufficient sitting height, leg and arm length and muscular strength.

c Satisfactory functional use of the whole musculoskeletal system including all four limbs.

d Significant sequelae from disease, injury or congenital abnormality with or without surgery.

The use of drugs employed in the treatment of musculoskeletal disorders must be assessed in accordance with JAR–FCL 3.115.

The assessment of the musculoskeletal system will be discussed systematically, starting with the general inspection and examination of the whole body and continuing from the lower extremity upwards. The spine will be discussed separately.

2 BONES, JOINTS, MUSCLES AND TENDONS

A careful inspection should reveal any significant abnormality or deformity of the bony skeleton. X-ray examination, as required, will show the detailed structure and possible signs of disease or trauma. The inspection also shows major deformity of the muscles and tendons.

2.1 Lower extremity

a *Ankle and foot*

A good range and painless movement of the ankle and subtalar joints are essential for the safe management and control of aircraft. There are many conditions, e.g. trauma or infection that could impair with this function. Painful foot or ankle injuries caused by sporting activities are common problems. The applicant's fitness to manoeuvre the aircraft will often require a medical flight test, either in a simulator or in the aircraft.

b *Knee*

The knee joint should be stable and there should be a minimum, painless, range of movement from 0 to 90°. The knee joint is probably most prone to injury. The development of the arthroscopic surgery has brought great improvements in diagnosis and treatment of common knee problems, e.g. a torn meniscus or a ligament or a loose intra-articular body. Recovery after arthroscopic surgery is also remarkably quick, enabling rapid return to flight duty only one to two weeks after operation.

c *Hip*

Osteoarthritis is the most common hip disorder affecting older pilots. A minimum painless range of at least 90° of flexion from the extended position in the hip joint is required. Occasionally an applicant will present with signs of congenital hip dislocation (not treated adequately in the postnatal period) or of Legg-Perthes disease (slipped upper femoral epiphysis). These cases should be diagnosed and assessed according to the functional abnormality. Any orthopaedic surgical operation of the hip area will need post-operational physiotherapy, therefore a minimum period of three months for unfitness will be required.

2.2 Upper extremity

a *Shoulder*

A good range of shoulder movement is essential for operating controls located in overhead panels and side consoles. Traumatic dislocations or fractures of the shoulder or the acromioclavicular joint are common sequelae of traffic accident and contact sports. These injuries are usually easily diagnosed and following proper conservative or surgical treatment the recovery is complete. Physiotherapy is often required to attain full mobility. Habitual shoulder dislocation should be treated surgically because a painful dislocation while operating aircraft controls, especially in the overhead panel, could lead to inflight incapacitation.

b *Elbow*

The elbow is also prone to injury. A certain amount of restriction at the elbow joint may be acceptable because some impairment can be compensated for by the shoulder movement. Most elbow problems are caused by acute trauma. The restoration of adequate function should be possible with surgery and physiotherapy. Epicondylitis (tennis elbow) is caused by extended repetitive stress in the insertion point of forearm muscles. This can become chronic and should be properly treated from the beginning.

c *Hand and wrist*

The assessment of the functional capacity of the hand and fingers should be made with a good knowledge of the complex aircraft control manipulations required for safe flying. There should be no major impairment of the three basic types of functions of the hand:

i to grasp cylindrical objects;

ii to pinch by tip, pulp or by lateral pressure;

iii to hook.

Complete intact sensibility and good finger and thumb movements on both sides are also essential for operation of computer displays and keyboards.

[A person with an amputated thumb should also be evaluated by a medical flight test, otherwise a single finger amputation is usually of no concern.**]**

2.3 Static physical disability

Many physically disabled pilots are able to compensate for their disability without a reduction in flight safety by a change in flying technique, a limb prosthesis, or the judicious use of assistance when on the ground. Whilst it is difficult to predict every possible problem a disabled individual may encounter when flying, or when undertaking flying-related tasks, there are some general principles which can be applied.

The pre-flight check must be accomplished adequately. A paraplegic pilot may not, for example, be able to visually inspect the fuel contents. In these circumstances, an assistant may aid the process. The assistant must be properly instructed as to how to carry out such a task. The applicant must also be able to exit the aircraft, without assistance, in the event of an emergency if

he/she wishes to carry passengers. If this is not possible without assistance, the applicant may still be accepted as fit to fly solo, but with the limitation that passenger carrying is not permitted.

All controls must be operated safely using aircraft modifications and/or limb prostheses as necessary. Aircraft modifications must be checked for airworthiness by the relevant department but prostheses do not normally need an engineering check, unless complete reliance on them is necessary. For example, a single upper limb prosthesis can be used to operate controls, but were it to malfunction in the air, a pilot could land a light aircraft using one arm only. In the situation of a double arm prosthesis, then the artificial limbs need to be assessed from the engineering viewpoint to ensure that they are reliable. Consideration needs to be given to pre-flight checking of such artificial aids.

Applicants may need to be restricted to flying with a "safety pilot" in the initial training stages, depending on their disability and they will need to successfully pass a medical flight test before being permitted to fly solo. This should be undertaken by an experienced examiner and preferably one who has experience in assessing disabled pilots. The attendance of a medical officer at the medical flight test can be helpful. It may be necessary to apply operational limitations different from the normal aircraft limitations e.g. a more restrictive cross-wind limit, depending on the aircraft modification or prosthesis.

Flying instructors of disabled pilots should, ideally, be qualified in the use of any hand controls (in particular) or any other device which enables a disabled pilot to overcome his handicap. If this is not possible, then it is desirable that a small number of instructors gain experience in this area and become familiar with the different techniques required.

3 SPINE

A careful examination by inspection, palpation and x-ray (when required) should be included in every assessment of the entire spine.

Any deformity should be evaluated to identify the underlying cause, e.g. a congenital malformation, trauma, sequelae of disease or a neoplasm.

In the case of helicopter pilots, extra care must be taken due to the adverse effects of vibration and the portural limitations of the flight controls. It may be necessary to X-ray the spine in order to evaluate congenital or acquired abnormalities which may be incompatible with helicopter flying.

3.1 Thoracolumbar spine

The spine consists of a column of vertebral bodies with inter vertebral discs capable of taking heavy loads. Any deformity of a vertebral body caused by spondylolysis or trauma (fracture) or the deformity of the column (scoliosis or spondylolisthesis) may interfere with the muscular balance leading to muscle spasm and pain. A leg length discrepancy or more than 15–20 mm is a common cause for muscular imbalance and scoliosis.

The compression of a nerve root by a prolapsed inter vertebral disc may also cause severe sciatic pain.

All cases of backache among aircrew should be carefully evaluated for possible anatomical origin.

Low back pain is very common in all occupations and in all age groups. The connection between occupational stress and low back pain is not obvious, neither is the connection between clinical low back pain and abnormal x-ray findings.

3.2 Cervical spine

The cervical spine is anatomically different from the lumbosacral spine in that it may be subjected to far greater strain as the result of its mobility rather that from weight bearing. Whiplash injury is common in minor traffic accidents, causing painful soft tissue pain.

Degenerative changes at C4-C7 levels are commonly found in people younger than 40 years, care must be taken in considering these as a cause for brachialgia, muscle weakness and impairment of hand functions.

4 OTHER CONSIDERATIONS

4.1 Sitting Height, Leg And Arm Lengths, Muscular Strength

The sitting height, arm and leg length of an applicant should be evaluated bearing in mind the ergonomic requirements of the cockpit. The applicant must be able to reach readily and operate effectively all controls during both normal and emergency conditions. Special attention should be given to the applicant's ability to read all instruments including the HUD display and at the same time to reach the extreme positions of both rudder pedals and the hand controls Because of different cockpit designs great variations in ergonomic requirements exist. A medical flight test is often indicated.

Muscular forces needed to operate aircraft controls vary greatly. Most switches and knobs can be moved with one finger and modern aircraft, using electric or hydraulic actuators, demand minimal hand or foot movement and muscular power. In older aircraft with wire-controlled ailerons, elevator and rudder muscular forces needed during normal flight are also moderate, but emergency procedures resulting in asymmetric flight may require considerable muscular strength. Any deficiency in muscular power of the applicant must be assessed taking into consideration the type of aircraft to be flown. A medical flight test is often indicated.

4.2 Injuries and incapacitation

Musculoskeletal injuries are common. They occur most often during leisure or sports activities or in traffic accidents. Muscle spasms due to distension of the muscle fibres cause temporary discomfort and heal rapidly.

A distortion of a major joint will result in incapacitation of 2–3 weeks. A ligament trauma may have to be operated upon which will require 4–6 weeks of immobilisation. Most fractures of the extremities will require at least six weeks of immobilisation. An assessment should only be performed after convalescence if a significant decrease in function is expected.

[Amdt. 1, 01.12.00]

INTENTIONALLY LEFT BLANK