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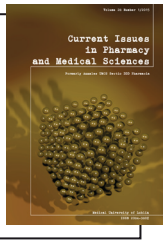

Epidemiology and pathogenesis of thoracic outlet syndrome

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ARTICLE INFO

Received 23 September 2014
Accepted 14 January 2015

Keywords:
subclavian artery,
thoracic outlet syndrome,
cervical ribs,
brachial plexus.

ABSTRACT

The superior thoracic aperture is a place particularly vulnerable to the occurrence of tissue conflict and the development of a number of neurovascular changes carrying a risk of upper limb dysfunction. The triggering factor in this case is the pressure on the nerve vascular elements brought about by too large muscles of the chest and neck, clavicle fracture and dislocation of the upper ribs, anomalies in the form of ribs, in the neck, or by apex of the lung tumors. Each anatomical anomaly may be a cause of a number of lesions and lead to the development of the disease. Due to the nature of the oppressed structures, there are two basic groups: neurogenic and vascular. The most common variant giving clinical symptoms is neurogenic thoracic outlet syndrome. In this, the compression ratio, the brachial plexus, and for this reason, the vascular surface of the upper limb dysfunction is often overlooked. However, the vascular variant, and especially arterial sub-variant, is very dangerous because it can give complications even in the form of aneurysms, and even upper limb ischemia. The aim of the study is to present the most common changes in the thoracic outlet causing functional disorders of the upper limb.

INTRODUCTION

The term 'thoracic outlet syndrome' (Thoracic Outlet Syndrome - TOS) was first introduced by Peet in 1956 [10]. TOS is a clinical syndrome resulting from neurovascular disorders in the space defined between the outer surface of the clavicle and upper ribs. It is brought about by compression of the neural structures, as well as the blood vessels located within the thoracic outlet [3]. Such a compression may include the brachial plexus, subclavian artery, subclavian vein and axillary vein. This compression often occurs in reduction places of bundle anatomic vascular disorders, muscles within the inclined slot, the rib-clavicular, and in the space between the coracoid process and the pectoralis minor tendon. The factors leading to the formation of the TOS may be congenital or acquired causes. Acquired causes most often have their source in post-traumatic complications or may be due to tumor growth. In contrast, congenital causes include anatomical defects such as cervical ribs [6].

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TOS is categorized as being either vascular or neurogenic. The first occurs much less frequently. Herein, compression of the brachial plexus elements leads to impaired upper limb function (rarely affecting both limbs). Displayed symptoms include pain and sensory disturbances. Prolonged pressure on the blood vessels can also induce complications that are associated with the force and duration of compression of the vessel. Compression of the subclavian vein leads to a reduction of blood returning from the periphery, and as a result, bruising and swelling of the upper limb may occur.

The arterial vascular type can produce symptoms of both acute and chronic upper limb ischemia. In the case of chronic oppression, subclavian artery pressure and increase blood flow at the site of stenosis may occur, and may lead to the creation of local complications (aneurysms). In special cases, occlusion can arise which may lead to vessel embolism [1].

OBJECTIVE OF WORK

Presentation of the most common changes in the thoracic outlet causing functional disorders of the upper limb.

 DOI: 10.1515/cipms-2015-0036

EPIDEMIOLOGY

The incidence of thoracic outlet is, at least, 1-2% of the population. What is more, approximately 50% of all patients complain of pain in the upper limb, including numbness and tingling in the band compression of the thoracic outlet. Women are more prone to TOS than men, at a ratio of approximately 3:1. The age range of occurrence of symptomatic TOS is between 20 and 60 years old, but there are also cases found of the syndrome in children aged 10-14 years [13].

Vascular TOS in the general population are the least likely, and relate mainly to young people up to 35 years of age. It should be noted that the symptoms involving the venous system occur much more frequently than that from the arterial system. However, with increasing age, the incidence of neurogenic TOS also increases. Neurogenic TOS incidence is the most common (94-97%), the less common is venous (approximately 5%), while arterial TOS is the least common (less than 1%) [4].

The factors which predispose the individual towards the formation of TOS can be divided into innate and acquired. The respective movements involved in the formation of TOS is connected with the frequency of their occurrence. Development anomalies in the form of cervical ribs are extremely rare, and the frequency of detection of this defect is estimated at 1-2% of the general population [15].

In turn, broken ribs and broken clavicle mainly concern children and the elderly. Fractures of the clavicle account for 5% of all fractures and 44-66% of all fractures of the shoulder girdle. The imperfect union or union with displacement of bone fragments can lead to the oppression of both vascular and nerve structures.

Abnormalities in the anatomy of thoracic outlet can also be caused by a tumor mass originating from the top of the lungs. The incidence of tumors of the thoracic outlet is 1-3% of all lung cancers [5].

PATHOGENESIS

Changes of compression, regardless of the etiology, trigger characteristic symptoms. Most often these occur in people whose work is connected with frequent lifting and abduction of the upper limbs above the level of the shoulders. In such activity, the force of compression upon elements of the brachial plexus and blood vessels through the collarbone and upper ribs is the greatest. However, while the limbs are in the neutral position, pain symptoms may not be granted. The causes of these disorders are related to, inter alia, the work performed, the practiced sports discipline, developmental disorders and proliferative diseases.

Disclosure or symptoms are associated with the adoption of faulty postures such as the abolition of kyphosis and lordosis physiological or tilt of the pelvis. A particular body position related to the asymmetric setting of the rim shoulder may also predispose to the formation of TOS. Working at a computer or practicing sports related to the development of muscle mass, the tilted and abduction of the arms, as well as assuming an uncomfortable position during exercise, may be the reason for the emergence and development of TOS. However, not only an excessively developed muscle mass, but also having a small, asthenic physique may favor the emergence of TOS. This can be seen in the professions of jockey or ballerina. Moreover, in obese women with large breasts, or in women after radical mastectomy or the placement of breast implants, anatomical disorders of the shoulder girdle can also be evidenced. Onset of compression can be also caused by long-term, forced positioning of limbs during sleep. Of note, the aforementioned are just examples which do not cover all situations of daily life.

INJURY CAUSES

Chest injuries are a rare cause of TOS. Frequently this comes about as a result of traffic accidents where the collarbone is broken and the front part of the upper ribs are injured. This narrow space is the location of several nervous tissue and blood vessels that can be significantly compressed. The most predisposed injuries towards inducing such compression are fractures with a high-displacement or comminuted fractures. Fractures of the clavicle do not cause problems either diagnostic or treatment-related. However, complications of fractures of the clavicle in the form of imperfective nonunion, or pseudarthrosis producing nodular hyperplasia formation at the periosteum union, may lead to the oppression of neurovascular structures within the thoracic outlet and cause TOS [8]. Most often, the clavicle is broken in half of its length, which predisposes to a substantial presence of chipping bone fragments which move with respect to each other. Moreover, the proximal portion of the clavicle is pulled upwards and backwards by the sterno-clavicle-gland muscle. This can cause damage to blood vessels and nerve structures running in the vicinity of the damaged collarbone. Further fragments of broken collarbone, if the blade has been broken, are well stabilized by the raven-clavicular ligament, which prevents movement of the broken distal clavicle. Of note, complicated treatment of clavicle fracture may cause a significant risk to the health and even the life of the patient.

SKELETAL MUSCLE CAUSES

Bone abnormalities may be a potential cause of TOS. Their incidence is estimated at 29% of all TOS. The most common bone abnormalities include that of the cervical rib (70% of cases), irregularities of the clavicle (20%), and that in the different structures of the first rib (10%) [16]. Cervical rib abnormalities may affect the free course of neurovascular structures near the thoracic outlet and be the cause of their oppression, and, consequently, induce dysfunction of the upper limb. The ribs are the most common source of cervical plexus compression, less of blood vessel compression. With regard to this, brachial plexus paralysis symptoms and ischemia worsen while lifting the upper limbs, as a result of increasing compression in a confined space between the cervical rib, clavicle and bony chest wall [12].

Cervical rib abnormalities may traumatize elements of the nervous and vascular systems, giving neuropathic symptoms resulting from reduced blood flow through the vessel. The most common symptoms can include paresthesia, pain

located in the area of additional ribs, muscle atrophy and paresis of the upper limbs. Rib abnormalities may also induce neck aneurysms and thrombosis [2].

The factor predisposing to the development of the TOS may be the crossing of the subclavian artery, the subclavian vein and brachial plexus elements between the front sloping muscle and center in the so-called 'muscle inclined front slot' [13]. In particular, clinical symptoms often occur in people with a fine physique, and those with oversized muscles. The severity of symptoms in the form of pain and temporary upper limb ischemia occurs during rotation of the head toward the opposite shoulder [9].

As to bone anomalies, these have the strongest relationship with changes in arterial function (54%), but are less common with venous and rarest with neurogenic changes [16].

PROLIFERATIVE CAUSES

The brachial plexus and the course of blood vessels can be damaged by apex of the lung tumors [5].

A tumor located on top of the lung, by the infiltration of structures found in this area, can bring about a set of characteristic symptoms, including pain and swelling of the upper limb. It should be emphasized here that beyond this, generally there are no typical symptoms of lung cancer such as cough, hemoptysis and dyspnea [11]. Tumors found in this location are commonly called 'Pancoast tumors' - from the name of an American radiologist Henry Pancoast, who first described the impact of a tumor localized in the upper opening of the chest, on the upper limb dysfunction.

Tumors located within the thoracic outlet quickly fill the chest wall, clavicle and blood vessels extending in the vicinity. Moreover, they very often infiltrate components of the brachial plexus. The Pancoast tumor, or 'thoracic outlet tumor', is a condition which comprises about 1-3% of all lung cancer cases [14].

The syndrome of thoracic outlet can also be induced by a tumor of the first rib. Generally such a causal agent is fibrodysplasia, however TOS may come about due to bone metastases of breast, kidney or prostate cancer [7].

Another source are neuroblastomas or mild, generally slow growing tumors derived from the Schwann cells. Schwannomas of the brachial plexus are quite rare, and symptomatic neuromas are even rarer [17].

CONCLUSION

There are many reasons for functional disorders of the upper limb. A rare cause of these disorders, although very serious in consequences, is the syndrome of the thoracic outlet. Frequently, its occurrence comes about due to malformations, trauma, muscle disorders or malignancy. As a result of these changes, haemodynamic and neurological disorders develop, manifesting themselves clinically as a paresthesia.

Vascular TOS do not belong to the most common class of TOS, but can be very dangerous, because in extreme cases, they can bring about temporary lack of blood flow, and, consequently, even occlude the blood vessels, resulting in limb ischemia [4]. A complication of prolonged oppression of the artery is poststenotic aneurysms, and in the case of the oppression of the veins, venous thromboembolic disease of the upper limb. This is confirmed by numerous studies [1,2].

The most common cause of pain in the upper limb extremity is brachial plexus oppression. Because of this, vascular dysfunction at the base of the upper limb is often overlooked. The consequence of such a fact is that reported arterial TOS are rare since these disorders cannot be detected in many patients.

As it can be seen, TOS can be brought about by way of various reasons, the symptoms of which can be associated with varying intensity and be shared by vascular and nervous syndromes. Effective treatment of TOS is subject to the proper diagnosis based on both physical examination and imaging studies. Regarding the last, angiography and venography should be of special importance.

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