ELBOW STIFFNESS – NATURE AND ETHIOPATHOGENESIS

(Review)

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Abstract
The elbow joint is an intermediate motor unit of the upper extremity, responsible for the positioning the forearm and hand at various heights and positions in space. The stiffness of the elbow joint is an issue of social significance, because it has a particularly large effect on the capability of performing basic everyday actions, and various labor and household activities. This document aims at presenting the anatomical specificities of the elbow joint – the reason for its high reactivity, to summarize the reasons and pathogenic factors of the elbow stiffness. The detailed knowledge of the changes occurring in the tissues after various pathological processes, their pathogenesis and appropriate share in each specific case of elbow stiffness, is of great significance for the treatment and dealing with this condition.

Keywords: elbow joint, anatomic-physiological specificities, pathological factors, ethiological factors, pathogenetic factors, elbow injuries, extension, flexion.

INTRODUCTION
The elbow joint serves as a connection between the upper-arm and the forearm and puts the arm in a proper position for performing fine movements. It is a load-carrying joint during activations in a closed kinematical circuit, and acts as a stabilizer, during lifting, carrying, pushing, pulling and throwing. In order to allow independence in the daily activities of the upper extremity, as well as to ensure the biochemical requirements for work and rest, the elbow joint must have mobility, stability, strength and to be painless, (Da’vila, Johnston-Jones, 2006). In medicine, the term stiffness /contracture/ is used to signify conditions (usually pathological) of contracture of muscles or other soft tissues, situated around the joints, which obstructs the complete range of motions (Bankov, 1991; 2009). The contracture of the elbow joint causes significant discomfort and suffering, because the limitation of the range of motion makes it impossible for the arm and hand to be positioned in their proper position in space for the performance of various everyday activities. In the absence of a functional range of motion of the elbow joint, the function of the upper extremity is significantly limited (An, Morrey, 2000).

The objective of the scientific report is to reveal in a theoretical and practical aspects, the nature of the elbow stiffness, presenting and summarizing the reasons for the high reactivity of the joint, the ethiological and pathogenic factors of the elbow stiffness.

METHODS
This study employs the method for a theoretical and logical analysis of the published scientific reports, related to the discussed problem.

DISCUSSION
According to Morrey, Askew, Chao (1981) & Sojberg (1996) the normal range of motion of the elbow is 0° to 145°. A 50% reduction of elbow’s mobility may result in an 80% reduction of the functionality of the upper extremity (Sojberg, 1996). Based on a number of interviews with patients, Morrey, Askew & An (1981) defined elbow’s functional range of motion, which is 30° for the extension, 130° for the flexion, and 50° for both the pronation and supination. They proved that this range of motion is necessary to perform most everyday activities. The patients, interviewed by the authors, replied that with this mobility they are capable of performing 90% of all their activities.

The deficiency in extension is usually higher
than the flexion deficit after most traumas and its recovery presents a greater challenge to both the therapist and the patient. The extension deficiency can be compensated by means of inclining the body towards the target, but it is impossible to compensate the elbow flexion of less than 105° - 110°, through bending the neck and wrist, in order to reach the face (Morrey, Askew & An, 1981). The range of motion in the elbow joint is of key importance for moving the arm and hand in space to perform various functional activities. For example – tying one’s shoelaces requires elbow extension, the use of a telephone and eating both require elbow flexion, and turning a doorknob requires forearm rotation (MacDermid & Michlovitz, 2006).

**Anatomic preconditions** for the high vulnerability and impetuous reactivity of the elbow joint to traumatic moments.

Elbow’s predisposition to stiffness is due to several specificities, resulting from joint’s anatomy. These are the high congruency of the joint surfaces of the articulating bones, the connection of 3 continuous joints, within one and the same synovial cavity and the direct positioning of the joint ligaments next to the articular capsule and the surrounding muscles.

The three articulations of the elbow, art. humeroulnaris, art. humeroradialis and art. radioulnaris proximalis, are enclosed in one and the same articular capsule, which is equally thin and vulnerable to injuries. The articular capsule manifests predisposition to various biochemical and structural changes, even after minor injuries, it reacts through thickening and loss of the elasticity of its tissues, which results in a loss of the motion in the elbow. In the contracted articular capsule there is an increase of the collagen ligaments and decrease of the proteoglycan content and the total amount of water (Akeson, Amiel-Abel, Garfin & Woo, 1993). After an elbow injury and a subsequent immobilization, the articular capsule may contract by 3-4 mm (Morrey, 2000, Nirschl & Morrey 2000; Hotchkiss, 2005). The articular capsule of the elbow joint is abundantly supplied with nervous terminations, coming from several nerves, one of which is the median nerve, which carries a large number of vegetative fibers. The specificities of the innervations can also be explained with the extended areas of irradiation of the nervous pulses, occurring after a suffered injury, thus causing an increased reflector reaction of the surrounding muscles.

Bankov (1975) carried out clinical electromyographic studies of m. biceps brachii and determined that this muscle is extremely reactive and often reacts with a spasm (active muscle contraction) after various injuries of the elbow articulation. Another muscle, acting as the main flexor in the elbow joint - m. brachialis has a leading role in the formation of the flexion contractures in the articulation, due to the fact that fibers of the muscle are attached to the anular ligament and are connected to the articular capsule from the medial side. The fact that the muscles of the elbow joint is intimately connected to the articular sack, further adds to the increased reactivity of the muscles, resulting from a joint injury.

The lateral ligaments of the elbow are relaxed at 70° and 100°, which further adds to the flexion contracture of the elbow (Tucker, 1978).

These anatomic specificities of the elbow articulation are significant for the rapid formation of contracture in the articulation after an injury, with a subsequent immobilization or after a morbid process. They justify a careful selection of therapeutic methods and for the application of a delicate approach in the treatment of this condition.

**Ethiopathogenesis of the elbow stiffness**

The elbow joint stiffness is due to pathological changes, occurring in the tissues, functionally related to the articulation, as a result of the following ethiological factors:

- **mechanical trauma**, which may be a fracture, luxation or sprain of the articulation, rupture of ligaments, tendons, muscles of articular capsule, or microtraumatic injury (Cooney, 1995); The most frequent complication after a fracture is the elbow stiffness, which may result also from seemingly harmless fractures or fractures with minimum displacement (Ennis, Miller & Kelly, 2008). According to Regan & Reilly (1993) each trauma of the elbow articulation may obstruct the normal articular relations, which are an important factor for the normal motion of the joint, and a fracture or luxation of the elbow, which require a temporary immobilization of the joint result in a residual stiffness.

- **a prolonged immobilization**, following an injury, an inflammatory process or caused by a extended periods of patient’s being bedridden, which results in a limited mobility of the respective motor segment (Cooney, 1995). The more significant flexion contracture of the elbow articulation is related to the prolonged immobilization after a joint injury (Mehlhoff, Noble, & Bennet, 1988; Subramanyam, Ujjwal, Prabhakar & Khitish, 2007).

- **improper treatment or improper post-fracture healing of the bones**, forming the articulation, which results in pathological changes in the articular surfaces and the articular cartilage or the formation of ectopic bone formation (Modabber & Jupiter, 1995). Each and every change of the articular surfaces may cause compression and limitation of the movements.

- **the diseases** of the connective tissue and the articulations, which may result in an inflammatory reaction and pain and limitation of the mobility or diseases of the nervous system, which result in pareses and paralyses (Popov, 2002).

The ethiological factors of the elbow stiffness are presented in fig. 1.

The above ethiological factors affect the structures of the elbow articulation and cause the secondary occurrence of pathological factors, which contribute to the aggravation of the articular contracture. The main pathological factors, occurring as a result of the trauma or morbid process, which accompany the
recovery processes of the tissues and affect the elbow articulation mobility, are referred to as pathogenetic factors of the elbow stiffness. The pathology of any of the anatomic structures, forming the articulation, affect its overall function and may unlock a chain reaction of progressively aggravation articulard dysfunction (Popov, 2009).

An aseptic inflammatory reaction occurs at the place of the injury, which accompanies the process of regeneration of the damaged tissues and defines to a significant degree the formation of the motive deficit. Secondary, the imposed immobilization, accompanying the treatment of the injury, depending on its duration, causes negative changes in the musculoskeletal system. The functional inactivity in a certain area of the locomotor system results in circulatory and lymphatic stasis with infiltration in the tissues of serofibrous exudates, which later produces cicatrices. The immobilization period, required for the regeneration of the tissues causes negative changes in the tissues, undamaged by the injury as well. These changes are extremely individual and depend both on the duration of the immobilization and on a number of other factors – age, sex, localization, reactivity of the body, overall physical and mental status of the individual (Popov, 2009).

The pain is the main pathogenetic factor, which limits the function of the elbow articulation. It results in the occurrence of a muscle guard, which is a reflector defensive reaction by the muscles around the articulation, manifesting itself by co-contraction of the antagonists, in order to stop the motion and protect from pain. It occurs as a result of the stimulation of the nervous receptors. Here a more clearly expressed tonic contraction of the stronger muscle groups – the flexors - can be observed. This defensive anti-pain reaction may be considered a pre-contracture phase. Often, upon pain’s disappearance, the anti-pain reaction disappears again. If, however, the pain syndrome persists longer (which can be facilitated by a long inflammatory process or a long immobilization), the defensive position may become fixed and habitual. Secondary pathological changes occur in the tissues, which result in the development of permanent contracture. The muscle guard may persist a long time after the pain has disappeared. The next stage of the muscle guard is the muscle spasm – a pathological condition of permanently increased muscle tone, as a result of local circulatory disturbances in case of overloading and micro-rheumatism. The affected are contracted, non-elastic and with reduced tensibility. This leads to unbalanced effect of the muscles on the joint, which may cause a prolonged retention in a position, enabling only a part of the volume of motion, and thus – the formation of a contracture.

Pitting oedema is a factor, which always accompanies injuries. It is manifested as a condition of abnormal increase of the intra-articular fluid, which produces expansion of the articular ligaments and capsule. They reach the limit of their elasticity and thus the motion in the joint stops, before reaching the physiological limits. The pitting oedema also results in increased intra-articular pressure which increases even more with every attempted movement of the joint, thus producing stimulation of the mechanoreceptors, located in the joint and provoking pain and a muscle guard.

The formation of cicatrices is another important moment in the pathogenesis of the elbow stiffness. In the course of the inflammatory and recovery processes, at first immature connective tissue is formed at the location of the injury, which gradually transforms into fibrous and cicatric connective tissue, which

![Fig. 1. Ethiological factors of the elbow stiffness](image-url)
is related also to densification and tightening of the cicatrix, followed by limitation of the motion and loss of articular functionality. The accretions reduce the mobility between the different tissues and between the different layers and fibers of a certain tissue. In this way they reduce the elastic capacity of the tissues and the slidability between them, which limits the articular mobility in one direction (Popov, 2009).

**Tissue contracture** - certain changes may occur in the soft tissues and especially in the muscles, as a result of the prolonged maintaining of a contracted position. In these cases adaptation-retraction of the muscles and other soft tissues occurs. The contraction of the articular capsule and ligaments develops slower than the contraction of the muscles and the dermal tissue. This may be explained by the better blood circulation of the muscles and skin and faster occurring processes therein. The contracture of the muscle fibers takes place not only due to the immobilization in a contracted position, but also when the muscle has to work within a limited range of motion. Another main pathogenetic moment for the development of the elbow contracture are the **bone deformations**, which may be caused by incorrect healing, due to improper bone repositioning in case of fractures, as well as due to degenerative changes, occurring in the bones and articular surfaces in case of arthroses. The bone deformation may also be a congenital condition.

The severe injuries of the elbow lead to complications, related to the development of pathology in the bone, which may result in clearly expressed stiffness and functional limitations. The **ectopic ossification** is a condition, which is related to the formation of pathological bone and it is a common term, referring to a heterotopical ossification, myositis ossificans and para-articular calcification. The reasons for the formation of ectopic ossification include the presence of not eliminated small bone fragments, near the articulation after the fracture (Hamblen & Harris, 1971) or the formation of haematoma after the injury (Riegler & Harris, 1976, Failla et al., 1990). The duration of the surgical intervention, along with the selection of a surgical approach and the size of the tissue dissection, also affects individual’s predisposition to the development of ectopic ossification in the area of the elbow joint (Christensen, & Kristensen 1988; Failla, Amadio, Morrey, & Beckenbaugh, 1990).

One of the signs for the presence of ectopic ossification in the area of the elbow joint is the swift loss of the range of motion or incapability of recovery of the range of motion, after the disappearance of the inflammatory processes after the injury.

**The articular blockage** is a condition of a damaged accessory articular mobility, occurring as a result of a dislocation of the articular surfaces or due to the presence of free intra-articular bodies. The articular blockage results in the presence of pain and a muscle guard, which – on its part, limits the range of motion of the articulation. In the event of a prolonged articular blockage, a muscle spasm can occur as well as the development of an articular contracture.

Fig. 2 shows the pathogenetic factors for the elbow stiffness.

The model of limitation of the active motion may be very indicative. The loss of flexion is typical for the osteoarthritis, as well as for the stiffness of the posterior capsule or tendinosis of the axillary triceps muscle. The gross loss of extension after an injury may be the result of a fracture of the olecranon, the limitation of the rotations is an indication of a damage of the radial head. A significant loss of motion, without any feebleness may be the result of a heterotopic ossification (MacDermid & Michlovitz, 2006).

In their study Ocarinoa et al. (2008) established

![Fig. 2. Pathogenetic Factors for the Elbow Contracture](image-url)
that the elbow stiffness increases after an intensive muscle training, involving the complete range of motion of the elbow articulation. According to a study of Myden & Hildebrand (2001) the range of motion in the elbow joint after various traumatic damages, may improve within a year after suffering the injury. The percentage of the significant combined contractures after traumatic damages to the elbow, which require surgical treatment, amounts to approximately 12% of the studied cases.

CONCLUSIONS
1. The anatomic and physiological specificities of the elbow stiffness are a precondition for vulnerability and strong reactivity of the articulation to traumatic moments, which makes it susceptible to the formation of contractures, as well as sensitive to radical treatment methods.

2. The ethiological factors for the elbow stiffness are responsible for the secondary occurrence of pathological factors, which contribute to the aggravation of the articular contracture. The pathology of any of the anatomical structures, forming the articulation, affects its entire function and may unlock a chain reaction of progressively aggravating articular disfunction.

3. The duration of the immobilization, the severity of the injury, as well as the extensive effect of the pathological factors, unlocked as a result of the injury or the morbid process in the elbow joint, are responsible for the severity of the articular contracture.

4. The good knowledge of the reasons and pathological mechanisms for the formation of the elbow contracture may help the prevention of this condition as well as to help the therapists in the selection of the treatment approach, aiming at the avoidance of the elbow articulation stiffness.

REFERENCES


КОНТРАКЦИЈАТА НА ЛАКТОТ - СУШТИНА И ЕТИОПАТОГЕНЕЗА

(Прељеден труд)

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Апстракт
Зглобот на лактот е меѓупросторна движечка алка на раката кој е одговорен за нејзиното поставување на различни височини и различни позиции во просторот. Контракцијата на лакатниот зглоб претставува проблем од социјално значење кој во голема мера, особено се одразува врз можнностите за самостојното извршување на различните работни и животни активности. Овој труд има цел да се согледаат анатомските особини на лакатниот зглоб, причините за нивните високи реакции, како и да се генерализираат причините и патогенетските фактори за контракцијата на зглобот во лактот. Целосното познавање на промените кои настануваат во ткивата по различните патолошки процеси, нивната патогенеза и соодветниот дел на учеството во секој конкретен случај на контракцијата на зглобот во лактот, е од големо значение за лечењето и подобривањето на таа состојба.

Ключни зборови: зглоб на лактот, анатомско-физиоложки особини, патолошки фактори, етиолошки фактори, патогенетски фактори, повреди на лактот, екстензија, флексија

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