

ANATOMO-PHYLOGENETIC ARGUMENTS FOR THE PRODUCTION OF MUSCULAR SPORTS INJURIES

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ABSTRACT. The striated muscles that appeared later on the phylogenetic scale have more white, fast fibers in their composition, more sensitive to metabolic aggression. Based on the composition, phylogeny and anatomical-functional characteristics, we selected the following muscles: semitendinosus, iliac, subscapular, extensor pollicis brevis and flexor pollicis longus. The data from the specialized literature show that the respective muscles are exposed to sports injuries. In principle, one can try to prevent injuries by changing the proportions in types of muscle fibers, possibly through physical exercises, but there is the potential danger of changing joint biomechanics.

Key words: *striated muscles, phylogeny, fiber types, sports traumatology.*

REZUMAT. *Argumente anatomo-filogenetice pentru producerea leziunilor sportive musculare.* Mușchii striați apăruți mai târziu pe scara filogenetică au în compoziție mai multe fibre albe, rapide, mai sensibile la agresiuni metabolice. Pe baza compoziției, filogeniei și caracteristicilor anatomo-funcționale am selectat următorii mușchi: semitendinosul, iliacul, subscapularul, extensor pollicis brevis și flexor pollicis longus. Datele din literatura de specialitate arată că respectivii mușchi sunt expuși traumatismelor sportive. În principiu se poate încerca prevenirea accidentărilor prin schimbarea proporțiilor în tipuri de fibre musculare, eventual prin exerciții fizice, dar exista pericolul potențial al modificării biomecanicii articulare.

Cuvinte cheie: *mușchi striați, filogenie, tipuri de fibre, traumatologie sportivă.*

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INTRODUCTION

Muscles that appeared more recently on the phylogenetic scale have a higher proportion of white muscle fibers (Wittenberger, 1971). These fibers are more sensitive to cancer cachexia, sepsis, chronic heart failure, diabetes (Wang & Pessin, 2013), and muscle atrophy can be a risk factor for sports injuries (Bahr & Holme, 2003). Moreover, fast fibers are the first to degenerate with age (Callahan et al., 2014), and the high proportion of fast fibers can be a risk factor for sports injuries (Delos, Maak & Rodeo, 2013). As a result, the current work aims to discuss some muscles of the human body that have recently appeared phylogenetically and highlight the relationships with sports traumatology. To the selection criteria of the respective muscles, we added functional and anatomical-topographical arguments intended to support their more recent phylogenetic appearance.

SEMITENDINOSUS, SUBSCAPULARIS, ILIAC, EXTENSOR POLLICIS BREVIS AND FLEXOR POLLICIS LONGUS

For the muscles of the posterior compartment of the thigh, the structural differences given by the different loads occurring depending on the phylogenetic development of the muscle group are risk factors for the production of injuries (Shi et al., 2022). Among these muscles, the semitendinosus muscle seems to have appeared last in the phylogenetic evolution, the hypothesis being supported by:

- Its separation from the Sartorius muscle is present only in frog species more phylogenetically evaluated (Inger, 1966).
- Its disposition in the most superficial level.
- The appearance of a physiological genu valgum in the 2-year-old child, which reaches a maximum at 3-4 years and resolves at 7 years (Patel & Nelson, 2023); the insertion of the semitendinosus muscle in the medial part of the body of the tibia, in the vicinity of the anterior ridge, shows its role in maintaining the bipedal posture, which appeared later in the phylogeny.
- In obesity, the prevalence for genu valgum is higher than for genu varum (Soheilipour et al., 2020), which also supports the role of the respective muscle in maintaining posture.
- Semitendinosus muscle can be affected in case of damage to the central motor neurons (Haberfehlner et al., 2016).
- In the case of proximal lesions of the biceps femoris, the common proximal tendon of the semitendinosus and biceps femoris thickens, but in the case of proximal lesions of the semimembranosus, the same tendon becomes thinner over time (Silder et al., 2008) – this finding, together with the analysis of

proximal and distal insertions, suggests a very interesting role of the semitendinosus, namely to supplement, through its later phylogenetic appearance, the functions of the other muscles in the posterior compartment of the thigh (biceps femoris and semimembranosus).

Fast fibers, appearing later phylogenetically, account for $65.8 \pm 10.1\%$ in men and $54.8 \pm 8.3\%$ in women of the composition of the semitendinosus (Fournier et al., 2022). These values for the fast fibers are superior to those in the biceps femoris (Evangelidis et al., 2017). So the semitendinosus, being more recent phylogenetically, is more specialized but also more sensitive to aggression. This means that the semitendinosus will be affected before the biceps femoris and probably also the semimembranosus in Cushing's syndrome, considering that in this disease the white fibers are destroyed first (Gupta & Gupta, 2013). So in the case of Cushing's syndrome or glucocorticoid treatments, physical therapy must focus on exercises for the lower limbs intended to stimulate the fast fibers, or on electromyostimulation for the fast fibers, to prevent postural disorders and those of the biomechanics of walking or running. The same considerations are valid for the prevention of sports injuries. It is also worth mentioning the effect of transforming fast muscle fibers into slow fibers in the case of supplementation with arginine (Chen et al., 2018).

Another muscle that appeared relatively recently phylogenetically is also the subscapularis, since the upper segment of the reptilian latissimus dorsi contributes to the formation of the mammalian subscapularis (Koizumi, 2022). Note also the fan shape of the subscapular muscle in humans, resulting from the complex rotational movements of the upper limb. In humans, the subscapularis has a higher proportion of fast-twitch fibers (62%) than other rotator cuff muscles (Lovering & Russ, 2008). This fact may explain the frequency of sports injuries produced in this muscle (Goldberg et al., 2022). Ruptures of the subscapular tendon are more common in diabetes or metabolic syndrome (Park, Gwark & Na, 2022). Given the fact that specific subscapular toning exercises are used (Altintas et al., 2019), an effective prophylaxis of sports injuries can be achieved in risk groups. Another relatively recent phylogenetic muscle is the iliac (Vaughn, 1956). It is similar in shape to the subscapular, but also in function - corresponding to the lower limb. I have not found information in the specialized literature regarding the muscle fiber composition of the iliac muscle in humans, but fast fibers predominate in the psoas (Arbanas et al., 2009), so it can be assumed that the iliac muscle has a similar composition. In septic patients, psoas atrophy was found without tendon wasting (Kubiak et al., 2019), so it is the sensitivity of white fibers to metabolic aggression. The isolated injury of the iliac was also described as an effect of poor technique in the execution of sports exercises (Magaña-Reyes et al., 2016), but the iliopsoas

injury usually occurs, being described in soccer players (Mozes, 1984). The iliac and the psoas make up a musculotendinous unit (Bordoni & Varacallo, 2023), therefore the exercises used to rehabilitate the tendinopathy of the psoas (Rauseo, 2017) can also be used as a means of preventing sports injuries in risk groups by toning the iliac muscle.

Among the muscles of the forearm and hand, extensor pollicis brevis and flexor pollicis longus are found only in hylobatids and in humans on the scale of phylogenetic evolution (Diogo, Richmond & Wood, 2012). The composition in muscle fiber types is not known, but extensor pollicis brevis injuries can occur during kettlebell exercises (Karthik et al., 2013). For the flexor pollicis longus, the composition in types of muscle fibers is not specified in the specialized literature either, but, like the muscle discussed above, it is susceptible to traumatic injuries (Poggi, Massarella & Piccirilli, 2021) (Qureshi et al, 2015).

DISCUSSIONS

The presented data suggest that phylogenetically newly formed muscles, richer in fast fibers, are even more exposed to sports injuries. The question arises whether injuries can be prevented by partially changing the proportions in muscle fiber types. The composition of muscle fiber types can change through exercise (Plotkin et al., 2021). This possibility has already been proposed for the prevention of muscle diseases (Talbot & Maves, 2016). However, the question arises whether this change in the proportions of the muscle fibers does not affect the anatomical and biomechanical articular positioning, with the appearance of specific ailments.

CONCLUSIONS

1. The semitendinosus, iliac, subscapular, extensor pollicis brevis and flexor pollicis longus are phylogenetically new muscles, rich in fast fibers, and for this reason exposed to sports traumatic injuries, against the background of pre-existing metabolic aggressions.

2. It is tempting to prevent sports injuries by changing the composition of muscle fiber types, possibly through physical exercises corresponding to the proposed purpose, but the question arises whether this would not change joint biomechanics.

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