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Study of the Influence of the Plantar Aponeurosis Mobilization on the Reduction of the Superficial Back Line Tension at the Competitors Training for Obstacle Runs

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Abstract

Introduction: *Running is one of the most frequently chosen forms of physical activity. The participants taking the specially constructed routes deal with not only the distance, but also many obstacles ranging from natural difficulties in the form of terrain and swamps, to artificially created balancing pits, ditches, fences, etc. [3]. The Obstacle Course Racing runs, in nature demanding in terms of physical condition for the athlete, must be preceded by proper preparation. Its lack in all running disciplines entail the risk of injuries, most common of which are plantar aponeurosis overstrain and injuries of other structures of posterior fascia chain.*

Purpose: *The purpose of this study was to investigate the impact of the plantar aponeurosis mobilisation on the tension of the entire superficial back line in people actively preparing for starts in obstacle runs.*

Material and methods: *A group of 40 people including 17 women and 23 men took part in the study. All study participants were in the 20-30 age range and trained regularly at least twice a week for at least six months preparing for the OCR competition. All study participants underwent three sessions of 10-minute plantar aponeurosis mobilisation, based mainly on deep tissue massage techniques and using fascia tools (Fazer). To assess the effect of the procedure, the subjects were tested both before and immediately after the mobilisation was completed, and the Thomayer test was chosen as the measurement method. All analyses were performed in the Statistica v.12 package. A significance level of 0.05 was used for all analyses.*

Results: *Analysis of the results in Table 3 gave grounds to establish significant differences between the mean results before and after p<0.01 for each of the three mobilisations. Significant differences were also found among the results before the first mobilisation and the results after the second mobilisation (p=0.001) and the third mobilisation (p=0.0001), and between the results before the first mobilisation and before the third mobilisation (p=0.011).*

Analysis of the results gave grounds to conclude that the average effect of the procedure during the first mobilisation was statistically significantly stronger than in the case of the second and third mobilisation. There were no significant differences between the average effect of the second and third mobilisation p>0.05.

Conclusions: *Mobilisation of plantar aponeurosis has an impact on the tension of the posterior anatomical chain in people training for obstacle runs. The average effect of the procedure during the first mobilisation is statistically significantly stronger than in the case of the second and the third mobilisation. The improvement in the range of motion of the spine flexion resulting from subsequent mobilisations tends to persist.*

Introduction

Running is one of the most frequently chosen forms of physical activity. The research shows that about 20% of physically active Poles declare training this sport regularly [1]. In the recent years the extreme OCR (Obstacle Course Racing) runs, commonly called runmagedons, are becoming particularly popular among enthusiasts of extreme experiences [2]. The participants taking the specially constructed routes deal with not only the distance, but also many obstacles ranging from natural difficulties in the form of terrain and swamps, to artificially created balancing pits, ditches, fences, etc. [3]. The OCR runs, in nature demanding in terms of physical condition for the athlete, must be preceded by proper preparation. Its lack in all running disciplines entail the risk of injuries, most common of which are plantar aponeurosis overstrain and injuries of other structures of posterior fascia chain [4].

Anatomy

Plantar aponeurosis is a structure that is a part of the deep fascia in the bottom part of the foot. In terms of biomechanics, it is a vital element providing connection between calcaneus and toes. This fascia starts at the calcaneus, from where it goes distally forming a number of slips running towards the plantar side of the forefoot, penetrating into both the lateral and medial intermuscular septum. Anatomically, the plantar aponeurosis can be divided into three slips: lateral, medial and central. While the lateral and medial slips have different character, the central one is the main element of plantar aponeurosis both functionally and structurally and in some sources is called the proper plantar fascia. The central slip in the middle of the sole length splits into five slips, each of which is attached to the tendon sheaths of the flexor muscles of the toes and joint capsules of the corresponding metatarsophalangeal joints. Some structurally weaker fibres run under the metatarsal bones heads and are attached to the skin tissue. The different character of the lateral and medial slips consists in transforming their initial tendon structure in the fascia of the flexor muscles of the fifth toe and big toe, respectively.

Biomechanics of the plantar aponeurosis and foot arch

The whole foot arch needs to be seen as an architectonic complex of anatomic structures, which the bones, joints, muscles, tendons and fascia are. They can be seen as the equivalent of palmar cavity, which, over the course of evolution managed to adjust perfectly to serve its new function resulting from bipedal locomotion, i.e. the optimal transfer of body weight towards the ground [7]. To understand better the biomechanics of the foot arch and the role of plantar aponeurosis in its architecture, it is necessary to briefly discus these relations. In general, the plantar arch consists of three arches arranged on the plan of an equilateral triangle, whose vertices are the individual points of support of the foot.

These points correspond respectively to the head of the first metatarsal bone, the head of the fifth metatarsal bone and lateral processes and the medial tuberosity of calcaneus. The support points are connected with each other by arches of the foot. The transversal arch is the shortest and the least arched, the lateral arch, in turn, has an intermediate height, while the medial one is the longest and at the same time the highest, and it performs the most important function in terms of biomechanics in both static and dynamic conditions [8,9].

Plantar aponeurosis plays very important role in transferring mechanical tension within the foot. Its main function is to support the longitudinal arches of the foot, mainly the medial arch [10]. In the free-standing position, these arches can be compared to a frame, in which the plantar fascia acts as a flexible element connecting both compressed elements. When the joints are subjected to body weight and the internal rotation of the tibia, the elongation of this arch is limited by the tension generated within the fascial structures [11]. The longitudinal bundle of plantar aponeurosis fibers makes it an important, passive element of stiffening the entire arch [12]. Studies have shown that cutting the plantar fascia resulted in a 25% reduction in its stiffness [13].

Mechanism of foot amortisation during locomotion

Both during walking and running there are alternately repetitive movements in the foot. The mechanisms in the foot are designed to cushion our steps. What definitely has to be taken into account in terms of this paper is the occurrence of foot inversion and eversion in each of these cycles. Shortly before touching the ground the foot performs the inversion movement, which consists in inversion, adduction and plantar flexion of the foot. As a result of this movement, the outer part of the heel is the first to contact the ground. Immediately after contact, the foot flattens because of further contact of its entire surface with the ground and a descending change in the position of the lower ankle, which at the end of the transfer phase sets in eversion. As a result of this movement, the plantar fascia tightens and supports eccentric muscle work supporting the arch of the foot. Along with the gradual transfer of body weight towards the forefoot and the transition to the rebound phase, inversion occurs again and the entire foot work cycle repeats [14]. When the weight is transferred onto the toes, their dorsal flex results in a strained plantar aponeurosis, which results in increased plantar flexion corresponding to individual metatarsal bones, and thus raising the longitudinal arch of the foot. This effect is described in literature as the Windlass Mechanism (Fig. 1) [15].

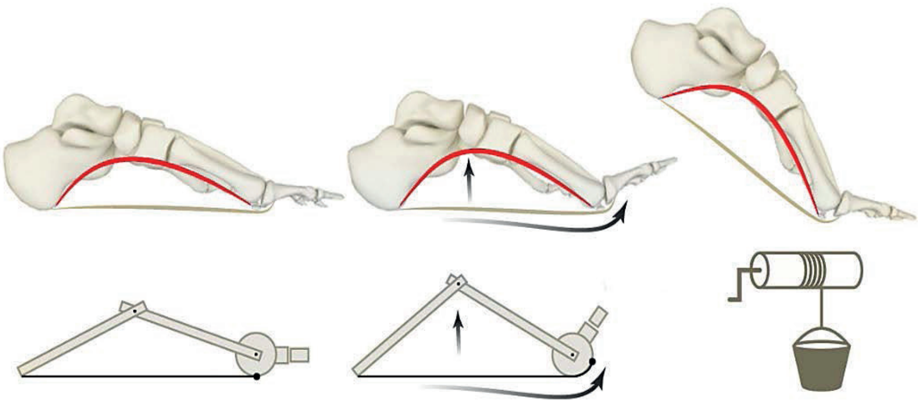

Figure 1. Model showing the operation of the Windlass Mechanism [15]

What definitely distinguishes the run cycle from the walk cycle is the occurrence of the flight phase. It results in the increased vertical movements of the body, and thus greater speed and strength when the foot touches the ground. Speed determining the load increase (Fig. 2) is definitely higher here and reaches its maximum after about 0.05 s, while for walk it reaches the value of 0.15 s. This fact along with the absence of double support phase means that the body weight is absorbed by one limb, and tissues are under more rapid and greater tensions. The vertical forces affecting the body during a run are directly related to the body weight. Usually, during the run the vertical forces of reaction of the ground assume values about 2.0-2.5 of body weight. As the running speed increases, the maximum force with which the foot hits the ground increases, and thus increases the speed of load increase, which is also supported by the decreasing time of contact of the foot with the ground.

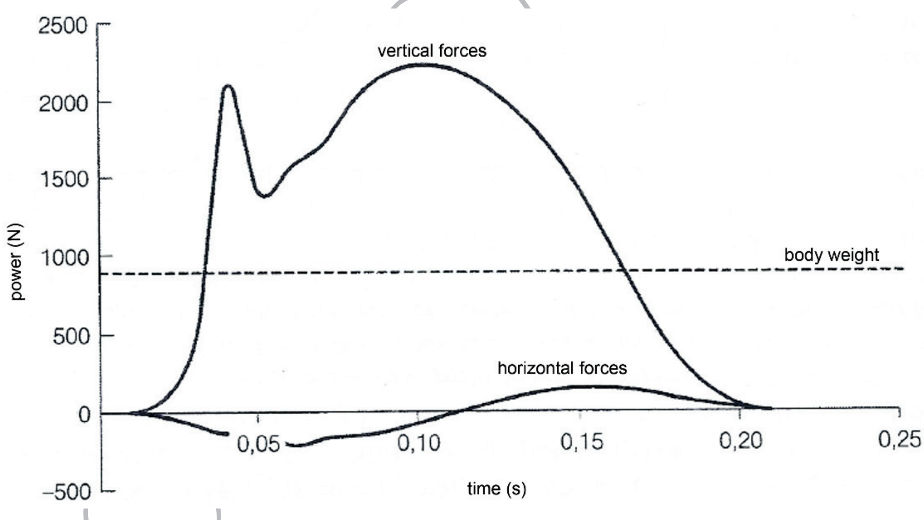

Figure 2. Distribution of vertical and horizontal forces during a run [16]

During both walk and run the body rises and falls as well as accelerates and slows down, which causes changes in potential and kinetic energy. Both change in mutually compatible phases, namely when the kinetic energy reaches a high value, the potential shows a significant increase in value, too. Achieving their maximum during running is facilitated by the mechanism of energy storage in tissues, e.g. Achilles tendon or fascial tissue, and then giving it away as elastic energy. Due to this phenomenon, the absorbed energy reduces the energy expenditure of muscles working actively in the rebound phase, further contributing to a significant increase in body acceleration [16, 17].

Characteristics of muscular fascial tissue

In very general way, fascia can be characterised as a kind of connective tissue ubiquitous in human body. It is a kind of „packaging" for all somatic structures of our body limiting their direct contact and enabling moving along each other by keeping them in the spatial network it creates. From the morphological perspective fascia consists mostly of various kinds of collagen fibres of varying thickness and spatial distribution conditioned by the type of function performed, as well as elastin fibres. Depending on the authors, the systematic division of the fascia usually involves several layers of this tissue. In the simplest way it can be divided into three basic groups: superficial, deep and muscular fascia. The superficial fascia includes subcutaneous connective tissue with irregular weaving, rich in numerous fat cells as well as cutaneous blood vessels and nerve fibres. This layer provides free movement of the skin in relation to deeper structures including deep fascia. Deep fascia is a layer built with compact connective tissue which surrounds all muscles and organs. It lacks the adipose tissue and the course of its fibres takes on a transverse, spiral or longitudinal orientation depending on the direction of the tensions it transfers. It creates intermuscular septa as well as tendon sheaths for nerves and vessels. The muscle fascia structure is compared to a three-dimensional matrix system that continuously runs over each of the muscle components, joining them into one functional whole. It builds respectively: epimysium, perimysium and endomysium. The epimysium layer surrounding each of the muscles transforms into a tendon and thus provides a connection between the muscular belly and bone tissue. The perimysium separates the bunches of individual muscle bundles. It stays, though, in close contact with tendon and epimysium, thus creating a uniform mechanical connection. The last of the listed layers is tissue surrounding each individual muscle fibres and ensuring their mutual integration, i.e. endomysium.

To sum up, muscular fascia is the tissue providing proper functioning of each muscle. By providing a network of connections between all its components, it plays an important role in regulating muscle tone, transmitting the strength of its contraction as well as preventing excessive stretching [18].

The fascial tissue has a high ability to regulate the tension in the myofascial system. Understanding fascial neurodynamics is the key to explaining the effectiveness of mobilisation techniques used in this work. The discussed function is possible due to the presence of numerous mechanoreceptors ensuring close integration of connective tissue with the nervous system [19].

Research clearly indicates that the fascia mainly consists of four types of nerve endings strongly sensitive to mechanical stimuli, which include:

- Golgi's tendon organs
- Pacinian lamellar bodies
- bulbous corpuscle
- interstitial receptors

A large part of them performs the function of chemo and thermoreceptors, however, according to current research, the largest percentage are mechanoreceptors. Due to the character of received stimuli, low- and high-pressure threshold fibres are distinguished here. Stimulation of the proper type depends on the intensity of the stimulus. Interstitial receptors interact closely with the autonomic nervous system, resulting in, among other things, change in blood pressure. The literature shows that they are responsible for tuning the UN responsible for regulating blood flow in tissues [20].

Basing on the conducted research, it can be clearly stated that all soft tissue mobilisation techniques affect their mechanoreceptors giving the effect, among other things, of change in the tension of myofascial structures. Stimulation of mechanoreceptors has a strong impact on the gamma-system of innervation in particular, whose centres located in the brain stem are mainly responsible for less conscious control of anti-gravity muscle tone. Those muscles regulate body posture and take part in programming the movement patterns. The possibility of regulating their activity through gamma motoneurons allows correction of functional disorders. This fact is the evidence of the effectiveness of manual techniques and the legitimacy of their use in therapy. Awareness of the existence of various types of mechanoreceptors and the effects of their activation allows to achieve the intended therapeutic effect, thanks to adequately adapted stimuli [21].

Superficial Back Line

One of the anatomic chains described by Myers is The Superficial Back lLne. Its elements include the following structures:

- plantar fascia, short flexors digitorum muscles
- Achilles tendon, gastrocnemius musles
- sciatic and shin muscles
- sacro-tuberous ligament
- sacro-lumbar fascia and dorsal extensor muscle
- epicranial aponeurosis

The function of the discussed chain is maintaining the erect posture of the body and preventing its forward leaning (postural function). Strong myofascial structures effectively regulate the extension and flexion of the entire body in the fibular plane. The muscles that make it up are made up largely of slow-twitch fibres, characterised by considerable strength. In turn, tension disorders in its course may be the reason for such pathological situations as: limitation of dorsiflexion in the ankle joint, contracture of the Achilles tendon and muscles of the sciatic-shin group, excessive pelvic tilt, or limitation of the flexion of the spine. From a therapeutic point of view, the fact that the tensions generated in any of the section of a given chain are transferred to its other elements causes that the restriction in one of them can be the reason for restrictions even in the most distant ones [22, 23].

Biomechanical model of the human body based on myofascial tapes is a scientifically proven fact. Many specialists from the world of physiotherapy and orthopaedics prove the validity of this theory and see in it the key to understanding the mechanism of many functional disorders of the musculoskeletal system. Plantar aponeurosis as a structure of the superficial back line is the first of many links in its entire chain. People who run regularly often put heavy loads on them due to the nature of the chosen sport.

The purpose of this study was to investigate the impact of the plantar aponeurosis mobilisation on the tension of the entire superficial back line in people actively preparing for starts in obstacle runs.

Material and methods

A group of 40 people including 17 women and 23 men took part in the study. All study participants were in the 20-30 age range and trained regularly at least twice a week for at least six months preparing for the OCR competition. Standard training units consisted of, among other things, endurance and functional training based on Crossfit.

All study participants underwent three sessions of 10-minute plantar aponeurosis mobilisation, based mainly on deep tissue massage techniques and using fascia tools (Fazer) (Fig. 3-6). The break between consecutive sessions was 2 days, during which the subjects led a normal lifestyle, regularly participating in standard trainings. To assess the effect of the procedure, the subjects were tested, both before and immediately after the mobilisation was completed, and the Thomayer test was chosen as the measurement method. According to the methodology, each participant was asked to stand with the lower limbs joined and let the torso fall forward with the upper limbs lowered freely, while ensuring full extension in the knee joints. After performing the above operation, using a tailor centimetre, the distance from the tip of the middle finger of the right hand to the floor surface was measured.

Figure 3. Mobilization of plantar aponeurosis with Fazer

Source: own.

Figure 4. Mobilization of plantar aponeurosis with the fist and heads of metacarpal bones

Source: own.

Figure 5. Mobilization of the lateral and medial plantar aponeurosis

Source: own.

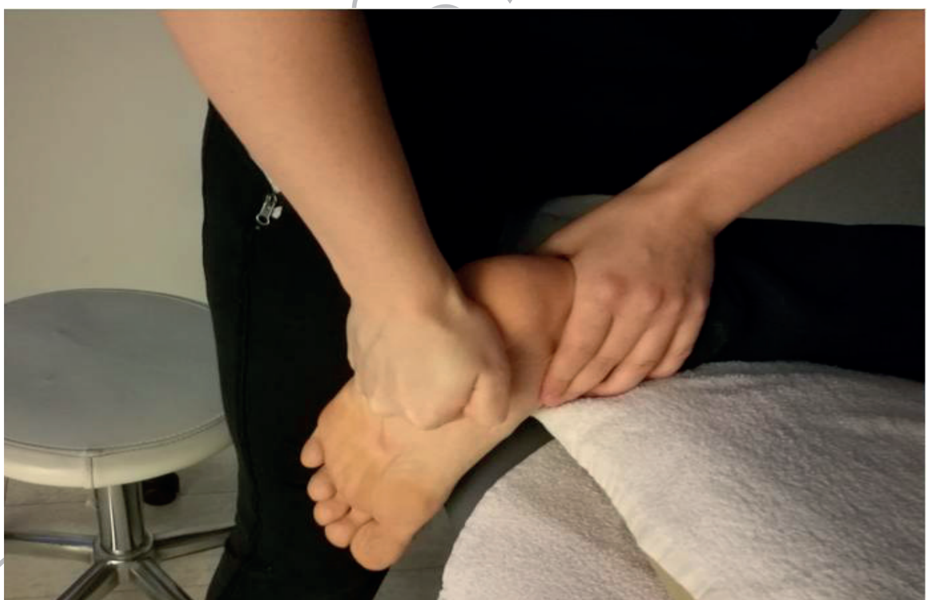

Figure 6. Mobilization of plantar aponeurosis with heads of the proximal phalanges

Source: own.

Quantitative features were evaluated in the study. The analysis of such data has its own specificity, which consists of using adequate statistical tools for comparisons. In order to characterise the structure of the studied variables, basic descriptive statistics were calculated in the form of measures of location, variability, asymmetry and concentration. To verify the significance of the differences in the before-after results and between mobilisations, analysis of variance with repeated measurements was used, to verify the significance of differences for the created variable that is the effect, i.e. the difference in the result before and after, in each mobiliation one-way analysis of variance was used. A significance level of 0.05 was used for all analyses. All analyses were performed in the Statistica v.12 package.

Results

Analysis of the results contained in Table 1 gave grounds for stating large heterogeneity of the results of the analysed variables, coefficients of variation V>20%. Asymmetry results – skewness allow the conclusion that all distributions are moderately asymmetrical, right-sided results are in the range of <-1, 1>. The concentration of individual cases around the average is very close to the concentration in the normal distribution. Kurtosis results are in the range of <-2, 2>. The next analyses concerned the verification of the significance of differences between individual measurements and mobilisations.

The analysis of the results included in Table 2 gave grounds to reject the null hypothesis about the lack of differences and to accept an alternative one stating that at least between the two average values there were statistically significant differences p <0.001. The analysis of variance does not indicate, however, between which interactions there were significant differences. To figure that out, in the subsequent analyses the Tuckey's post-hoc multiple comparisons tests were carried out for equal multiplicities.

Table 1. Descriptive statistics of results obtained in the Thomayer test

Mobilisation		Average	Median	S (standard deviation)	V (coefficient of variation)	Slant	Kurtosis
I	before	4.60	4.00	3.51	76.37	0.66	-0.33
	after	3.10	2.00	3.10	99.97	0.84	-0.26
II	before	4.33	3.00	3.52	81.35	0.70	-0.29
	after	3.13	2.00	3.02	96.73	0.91	-0.09
III	before	3.53	3.00	3.17	89.94	0.78	-0.32
	after	2.52	1.00	2.89	114.50	0.95	-0.07

Table 2. Analysis of variance with repeated measurements

	SS	v	MS	F	P
BEFORE-AFTER *Mobilisation	19.600	2	9.800	18.98	0.000

Where: SS – sum of squares of deviations, v – degrees of freedom, MS – mean square of deviations, F- test statistics, p – statistical significance

Table 3. Tuckey's post-hoc multiple comparison tests for equal multiplicities in subsequent measurements

subclass No.	Mobilisa-tion	BEFORE--AFTER	{1} 5.9500	{2} 3.6500	{3} 4.3250	{4} 3.1250	{5} 3.5250	{6} 2,5250
1	I	before		0.0001	0.22	0.001	0.011	0.0001
2	I	after			0.94	0.98	1.00	0.63
3	II	before				0.0001	0.88	0.13
4	II	after					0.99	0.96
5	III	before						0.0001
6	III	after						

Analysis of the results in Table 3 gave grounds to establish significant differences between the mean results before and after p <0.01 for each of the three mobilisations. Significant differences were also found among the results before the first mobilisation and the results after the second mobilisation (p = 0.001) and the third mobilisation (p = 0.0001), and between the results before the first mobilisation and before the 3rd mobilisation (p = 0.011). The results are confirmed by the diagram presented below. Subsequent analyses concerned verification whether the subsequent mobilisations significantly differentiate the effect of therapy achieved during mobilisation. For this purpose, the difference between the before and after results for individual mobilisations was calculated and the average values and standard deviations in individual mobilisations were calculated. The results are shown in Table 4.

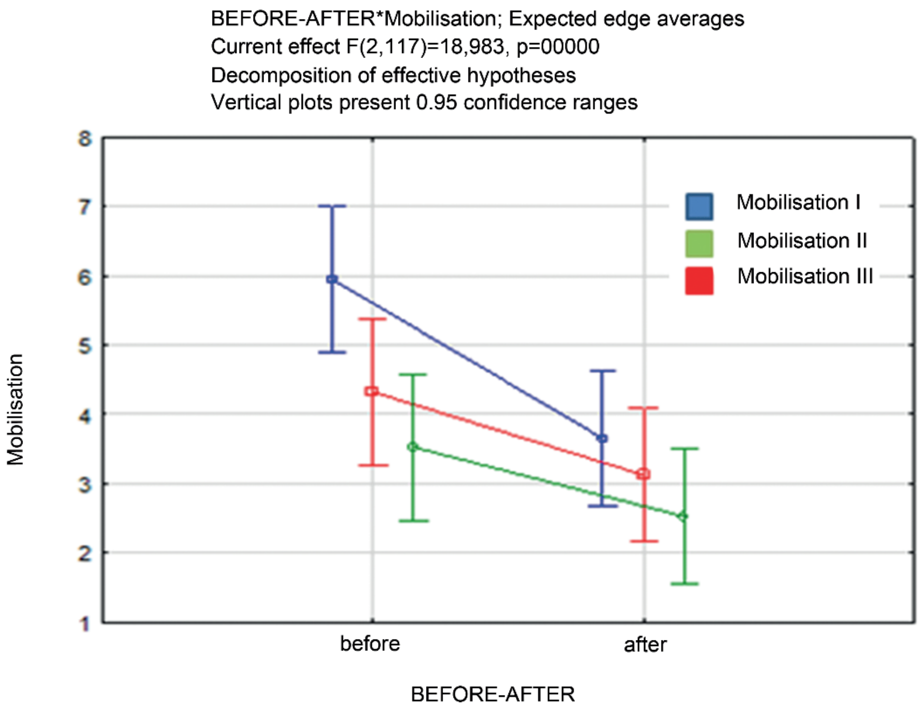

Figure 7. Comparison of average values before and after subsequent measurements in the finger-to-floor test

Table 4. Average values and standard deviations of subsequent measurements in the finger-to-floor test

Mobilisation	Delta effect (before-after) Average	Delta effect (before-after) Standard variation
I	2.30	1.22
II	1.20	0.85
III	1.00	0.93

In the subsequent analyses, a univariate analysis of variance was performed to verify whether the subsequent mobilisations significantly differentiate the effect of the procedure. Analysis results are shown in Table 5.

Table 5. Univariate analysis of variance

	F	P
Delta effect (before-after)	18.98	0.000

The results of the analysis of variance provided grounds for finding significant differences between Delta effects in individual mobilisations. To identify between which mobilisations significant effects occurred, Tuckey's post-hoc multiple comparison test was used.

Table 6. Tuckey's post-hoc multiple comparison test in subsequent finger-to-floor measurements

Mobilisation	{1} M=2.3000	{2} M=1.2000	{3} M=1.0000
I {1}		0.0001	0.0001
II {2}	0.0001		0.65
III {3}	0.0001	0.65	

Analysis of the results gave grounds to conclude that the average effect of the procedure during the first mobilisation was statistically significantly stronger than in the case of the second and third mobilisation. There were no significant differences between the average effect of the second and third mobilisation $p > 0.05$. These results are also confirmed by the graphical interpretation below.

Used as a research method to measure the obtained results, the Thomayer test also has its own interpretation. The universally accepted norm is considered to be the situations where the subject touches the floor with their fingertips while maintaining the full methodology of the implementation. Figure 9 is a graph showing the number of subjects who achieved an improvement in the range of motion at the level of the adopted norm in relation to the effects of individual mobilisations. None of the people participating in the study managed to touch the floor with their fingers with a free lowering of torso forward before the first mobilisation, but 10 people succeeded after the procedure. Before the second treatment, 5 people reached the normal range, and 11 after the mobilisation. In the context of the last attempt, 8 people showed the norm before using mobilisation, while 16 people in the measurement.

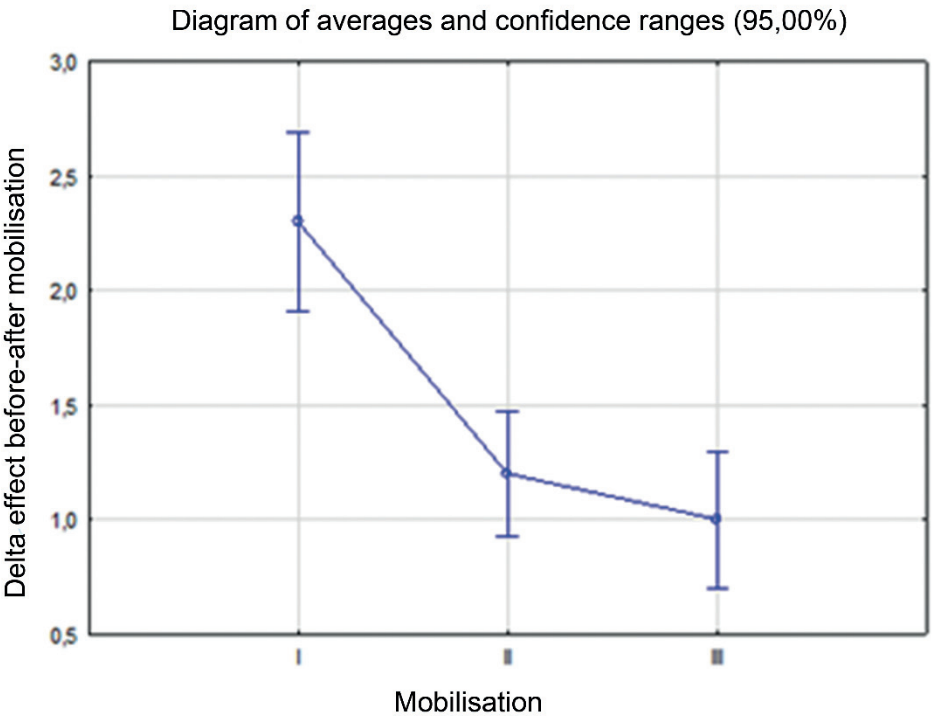

Figure 8. Comparison of average values in three analysed measurements

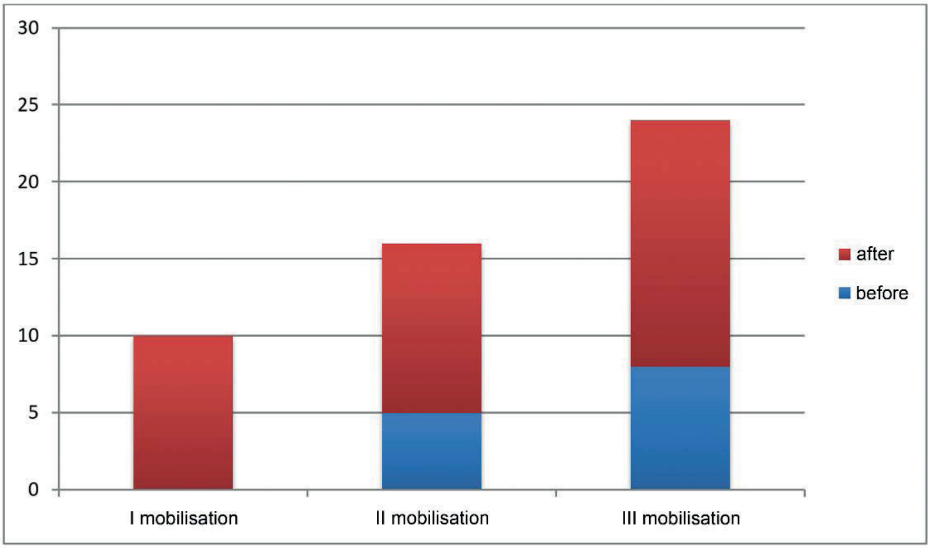

Figure 9. Graph showing the number of people surveyed who reached the extent of torso flexion within the normal range in the Thomayer test before and in relation to individual mobilisations

Discussion

The analysis of the presented results clearly shows that triple mobilisation of plantar aponeurosis in competitors regularly training to compete in the obstacle runs, has an impact on the tension of the posterior fascial chain. The conducted tests prove statistically significant differences among the mobilisation types with statistical significance at $p < 0.01$ in the Tuckey post-hoc test for average effects from individual treatments. The result of data analysis proves that the largest observed differences in measured ranges of mobility relate primarily to the first mobilisation ($p < 0.0001$) and this effect is slightly reduced with each subsequent therapy ($p > 0.05$ for each one). Based on the assessment of the average difference in the effect before, in individual sessions, they are as follows: 1.5 cm after the first mobilisation and 1.2 cm and 1.01 cm after 2 and 3. This result confirms the effect of the procedure, which unfortunately turns out to be weakening in subsequent attempts. These relationships also show that the improvement in the range of motion obtained in this way is not fully maintained but shows a slight tendency of tension return. This is shown in the compared average differences after 1 before 2, and after 2 before 3 mobilization, where the absolute values were 1.23 cm and 0.4 cm, respectively. This situation, despite a slight deterioration of the result, indicates the progressive durability of the obtained effect. However, to examine this aspect thoroughly, more trials would have to be carried out. Nevertheless, it emphasises the importance of introducing prophylaxis and maintaining adequate elasticity of the plantar aponeurosis in runners. The proof of its effectiveness may be the high post-hoc Tuckey statistical significance index for the analysed relationships: before and after the second mobilisation, where $p = 0.001$ and before the first, and after the third mobilization, where $p = 0.0001$.

Uryzaj et al. in their research presented the effect of deep tissue massage on the tension of the superficial back tape [24]. The study covered over 100 people randomly assigned to 6 groups in which they performed a single mobilisation of certain myofascial areas. In the research group where the plantar aponeurosis was massaged, an average increase in the range of motion in the torso forward inclination was obtained by about 4 cm with $p < 0.001$ statistical significance in the Wilcoxon test. Differences in the selection of the measurement method and less specific criteria for qualifying people to the study group and its size may affect the resulting differences in the average results obtained in both studies after a single mobilisation.

The same authors in a different publication tested in a similar way the differences in posterior anatomic chain tension after mobilising the epicranial aponeurosis, which wasn't included in the previous experiment [25]. The research results proved to be just as effective as it had been previously in relation to its other structures, because the difference in the range of motion of the spine flexion was 3-4 cm with a significance of $p < 0.005$ in the Wilcoxon test. The results of research of both the authors cited in the discussion and my own, which are the clou of the whole work, can be used as another proof of the validity of the model of biomechanics of the human body created based on the anatomical chains. Additionally, on the example of the plantar aponeurosis, which is a small link in the entire myofascial chain, one can see the integrity of all the structures that it consists of, where each of them, even the smallest one, plays a key role in regulating the tension of the entire system. Bearing in mind the above statement supported by the results analysed in this chapter, one should pay attention to the importance of maintaining adequate flexibility of all structures forming the given chains in the context of injury prevention in physically active people. Plantar aponeurosis mobilisation is a procedure that the therapist's hand is necessary for. In the circles of sports-active people, myofascial auto-loosening using all kinds of rollers and similar devices is becoming more and more popular. They are successfully used on all major muscle groups and their newer forms allow for matching the right size to the area undergoing self-loosening. In the case of plantar aponeurosis, an ordinary tennis ball or its more professional counterparts can be used for this purpose. Research on rolling provides grounds for establishing its effectiveness in maintaining adequate flexibility of the structures of the foot plantar side [26]. Therefore, attention should be paid to the possibilities and necessity of using the above-mentioned methods among physically active people, and particularly the ones training for running sports, as the results of research have shown.

Mleczkowska et al. conducted a study aimed, among other things, at determining the type of the most frequent injuries among runners. 64 regularly running people, mainly at an amateur level, took part in the study group. The research results have shown that since the beginning of their adventure with this sport, more than a half of them have suffered an injury at least once. According to the results of the research, one of the most frequently injured structures is the Achilles tendon (19.5%) and the plantar aponeurosis (14.6%) [27]. The frequency of injuries of these structures may indicate the problem of excessive overloading them among runners, which may result from inadequate physical preparation of the competitors themselves or the lack of flexibility of the myofascial tissue of the mentioned areas [28]. The results obtained from own research show an improvement in the elasticity of the structures of the posterior anatomical chain and the effect of the treatment lasting over time. The results presented in Fig. 9 prove the improvement in the spinal flexion range in the Thomayer test and maintaining it within normal limits in an increasing number of people tested with each subsequent therapy. Therefore, it can be said that the mobilisation and automobilisation of the plantar aponeurosis, permanently introduced into the training cycle of competitors training for running sports, may reduce the frequency of injuries in these areas. In order to further investigate this relationship, further research in this direction should be carried out on a larger group of subjects and observation of the long-term effect of these treatments.

Conclusions

1. Mobilisation of plantar aponeurosis has an impact on the tension of the posterior anatomical chain in people training for obstacle runs.
2. The average effect of the procedure during the first mobilisation is statistically significantly stronger than in the case of the second and the third mobilisation.
3. The improvement in the range of motion of the spine flexion resulting from subsequent mobilisations tends to persist.

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