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Effects of Fascial Manipulative Treatment on Bone Tissue

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Abstract

The experimental research, presented in this study, focuses on athletic tests with the purpose to highlight the elastic deformations of the bones of the lower limbs, intending to verify whether the manually treated anatomical structure increases in elasticity, becoming able to accumulate more energy in the loading phase, to then release it in the final phase of the thrust. **Introduction:** Too often neglected, the bone tissue is capable of deforming. The deformation has a key role in the cushioning and dissipation of stress, a function that is hindered in the event of fascial tension, which will consequently fall on other structures used for the same purpose (Discs, menisci, cartilage, …). Structures that, in the event of increased mechanical stress, could undergo degeneration, inflammation, and injury. **Materials and Method:** Randomized double-blind selection of 38 people, 18 in the treatment group and 20 in the control group, men and women, aged between 16 and 35, who have been part, for at least one year, of a sports club, with a large space dedicated to jumping in its training program, have been divided into two groups: the treatment group, which was treated to increase the performance of the jump and the control group subjected to mild manual pressures, without any intention. **Results:** The treatment group had an increase in Standing Long Jump (SLJ) for 3.67% ($p < 0.001$) while the control group had a decrease in performance for 1.12% ($p < 0.001$). **Conclusions:** This study has shown that an osteopathic manipulative treatment, aimed at increasing jumping performance, can increase the performance of the SLJ.

Keywords

Standing Long Jump, Fascia, Bone Tissue, Periosteum

1. Introduction

1.1. Bone Tissue Composition

Bone is a highly vascularized and innervated connective tissue composed of cells specialized in synthesis (osteoblasts) and degradation (osteoclasts), and mechanosensory functions (osteocytes) [1]. These cells promote the constant remodeling of bone tissue throughout life based on functional demand and are arranged in a hydrated mineralized extracellular matrix. The latter determines the mechanical qualities of the bone, being formed by organic materials (collagen and proteins such as proteoglycans and glycoproteins) allowing better flexibility. Inorganic materials, whereas (calcium and phosphate), provide strength to bone tissue [2]. Collagen has thixotropic and piezoelectric properties which permit continuous adaptation to the mechanical stresses imposed on the tissues.

Bones have an outer (periosteum) and an inner (endosteum) lining. The periosteum is made up of dense connective tissue that surrounds the outside of the bone, except for the joints. It protects, nourishes, and aids in bone formation and fracture repair. The endosteum covers the inner layer of cortical bone and is composed of loose connective tissue [3]. Sharpey's collagen fibers connect the periosteum to the innermost cortical regions of the bone as far as the endosteum, especially in areas exposed to increased mechanical stress. These fibers provide an important microanatomical continuity between the bone tissue components and their envelope [4].

1.2. Mechanical Properties

Measurement of stiffness, strength, and strain distribution of bones is extremely important for understanding bone biomechanics [5], bone formation and adaptation [6] [7], osteoporosis [8], and fractures [9].

The first experiments were carried out by measuring the torsional stiffness and strength of tibias and femurs whose samples were not tested in pairs, only some of the femurs and tibias came from the same donor [10], while others, more recent, predicted the comparison between the right and left side of the same subject [11] [12] [13] [14].

It is interesting to note how bones have a viscoelastic behavior, in which their viscosity varies as a function of the rate of deformation [15] and most of the deformation occurs in the first few seconds and represents 5% - 10% of the deformation immediately after load application [16].

Going into more detail, with the increase in the speed of deformation, the rigidity of the bone increases [17], this can be considered a form of defense of the bone itself since an increase in rigidity corresponds to an increase in resistance, but not only that, from the study, it was possible to notice how the resistance varies according to the direction of the deforming force, this means that the bones of the lower limbs are designed to deform in a certain way, they are optimized to withstand certain forces (**Figure 1**) [18] [19].

One aspect to take into consideration is the difference between the bones of the right side compared to those of the left side.

We highlight some important conditions that directly influence the mechanical properties of bone:

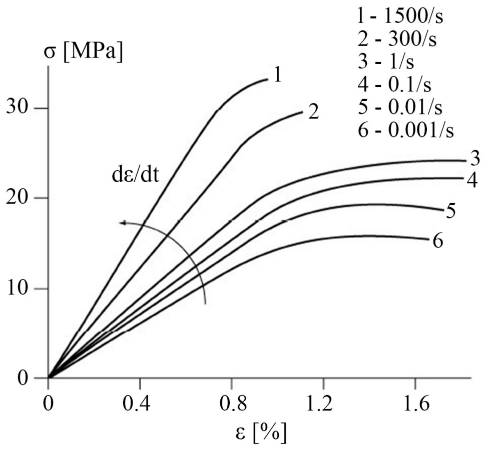

Figure 1. Stress-strain curve of compact bone as the strain rate varies.

- its deformation is not proportional to the load imposed on it;

- its mechanical properties vary according to the rhythm of the load;

- its mechanical behavior depends on the fluid present in the bone tissue;

- bone is composed of different types of bone tissue with different mechanical properties;

- its mechanical properties are not the same in all directions;

- is in constant remodeling and has different properties in different periods of life.

Mineralized matrix components promote strength, tension, and tensile-resistant collagen fibers that ensure bone tissue's flexibility and impart energy-absorbing capacity. Hence, collagen property changes directly affect bone's mechanical quality by increasing its susceptibility to fracture [20].

1.3. General Architecture of the Lower Limb

The curvatures of the bones of the lower limb depend on the action of the forces applied to them, according to Euler's law of "eccentrically loaded columns" (quoted by Steindler). When a column is articulated at its two ends (**Figure 2a**: free column loaded at both ends) the curvature occupies its entire height; this is the case of the posterior concavity curve of the femoral shaft (**Figure 2b**: lateral femur).

If the column is fixed at the bottom and mobile at the top (**Figure 3a**), there are two opposite curves, and the higher one occupies 2/3 of the spine: these curves correspond to that of the femur in the frontal plane (**Figure 3b**: frontal femur).

If the column is fixed at both ends (**Figure 4a**), the curve occupies its two middle quarters. This corresponds to the curvatures of the tibia in the frontal plane (**Figure 4b**). In the sagittal plane, the tibia has three features (**Figure 5b**) retro-torsion (t), posterior displacement; the retroversion (v) obliquity of 5˚ - 6˚ that tilts the tibial plateaus backward; retroflection (f), posterior concavity curvature of a mobile column at its two ends (**Figure 5a**), as for the femur.

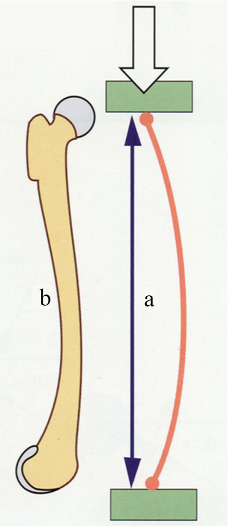

Figure 2. Curvatures of the femur in the sagittal plane.

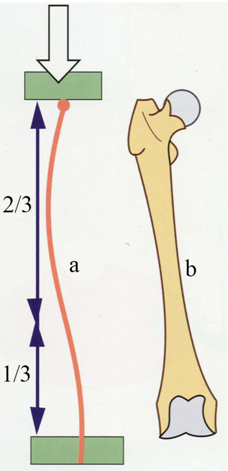

Figure 3. Curvatures of the femur in the frontal plane.

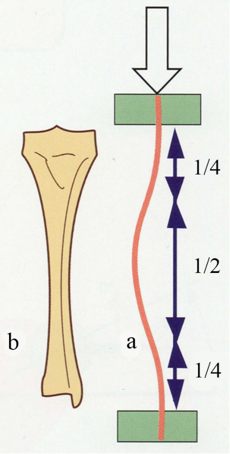

Figure 4. Curvatures of the tibia in the frontal plane.

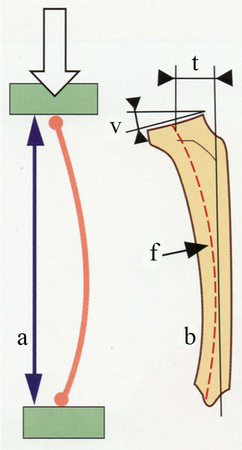

Figure 5. Curvatures of the tibia in the sagittal plane.

The opposing concave curvatures of the femur and tibia increase the space available between the two bones in extreme flexion, which allows for a greater volume of muscle mass to be placed between the tibia and femur.

It is a similar arrangement to that of the elbow, where the curvature of the joint ends offers greater space to place the muscle masses during flexion [21].

1.4. Can Bone Tissue Be Inserted into the Fascial Continuum?

The term fascia is highly used nowadays, even if there is still an inconsistency in its definition. Recently, it has been proposed that the fascial system: "…interpenetrates and surrounds all organs, muscles, bones, and nerve fibers, endowing the body with a functional structure, and providing an environment that enables all body systems to operate in an integrated manner. It incorporates elements such as adipose tissue, adventitia, neurovascular sheaths, aponeuroses, deep and superficial fasciae, epineurium, joint capsules, ligaments, membranes, meninges, myofascial expansions, periosteum, retinacula, septa, tendons, visceral fasciae, and all the intramuscular and intermuscular connective tissues including endo-/peri-/epimysium" [22].

Regarding bone tissue, most of the definitions usually consider only the periosteum as part of the fascial system. However, for Sharkey [23], definitions that do not include the other components of bone tissue as part of the fascial system are incomplete, as bone is a vital element for musculoskeletal continuity, and there is also a close embryological relationship between bones and the fascial tissue.

The author [23] points out that the concept of continuity of the fascial system also deserves importance when looking at the connection of ligaments and tendons in the periosteum, which in turn connects to the bone matrix through Sharpey fibers.

Bordoni and Lagana [24], conversely, proposed that bone tissue represents a specific part of the fascial system, considering some relevant aspects such as the microscopic anatomical continuity of tissues, the embryological origin of bone and fascial tissue, the autocrine and paracrine tissue activities influencing itself and other body structures and systems, and the mechano-metabolic responses of bone cells.

From these remarks, the authors [24] describe a new definition of the fascial system, which includes liquid and solid structures (such as bone) and adds features to the fascial tissue such as the ability to support, divide, penetrate, nourish, and connect all structures of the body [25].

1.5. Manipulative Treatment

In the medical literature, there are countless articles and publications on the efficacy of fascial manipulative treatment [26] [27]. Whereas the bone tissue is a tissue inserted in a fascial continuum, it is possible to treat the fascial tissue with specific techniques and treat the bone tissue acting on the periosteum and endosteum, even by making the bones more elastic.

2. Materials and Method

The study consists of conducting a manipulative treatment on the bones of the lower limbs and evaluating whether this produced an increase in jumping performance.

Since bones are characterized by intrinsic elasticity, in the thrust phase of the jump, they, subjected to an increase in vertical stress, go against elastic deformation. The deformation is the expression of the accumulation of energy, released in the detachment from the ground phase.

What would happen if the elasticity of the bones of the lower limbs were increased?

By increasing bone elasticity, bones can accumulate more energy in the loading phase, releasing greater quantities of it in the detachment phase and producing an evident increase in the distances covered in the jumps.

To simplify the concept, imagine leaping on different surfaces: sand, floor, or trampoline areas. It is obvious that the greater the elasticity (and therefore the accumulation of energy) there is in the loading phase, the greater the size of the jump will be.

To evaluate the increase in bone elasticity following the treatment, we should have gathered more information, testing, for instance, the pressure peaks exerted by a boy who lands from a given height on a baropodometric platform. Anyway, technology would have been too expensive to evaluate such slight differences.

2.1. Sample Selection

Randomized double-blind selection of 38 people, men and women, aged between 16 and 35, part, for at least a year, in a sports club mostly dedicated to jumping training programs (Basketball, volleyball, handball, …), from November 2022 to February 2023, were divided into two groups:

- The supervised group (SG), consisting of 20 people, was exposed to mild manipulative treatment, without any intention.
- The treated group (TG), consisting of 18 people, with the purpose to in-

crease the performance of the jump.

2.2. The Standing Long Jump

The standing long jump, also known as the standing broad jump, is an athletic specialty, included in the Olympic Games from Paris 1900 to Stockholm 1912. It was performed with the same principle as the long jump, with the difference that the athlete had to take off from the ground without running up.

When executing the standing long jump, the jumper stands on a line marked on the ground with the feet slightly apart. The athlete springs and lands using both feet, swinging the arms and bending the knees to propel forward.

2.3. Test Execution

The athlete was trained in the execution of the standing long jump, and he was offered the opportunity to perform as many tests as he felt necessary, in order to become familiar with the execution of that particular athletic gesture.

When the athlete felt ready, he was tested, performing the exercise as in the description in the previous paragraph, with 3 jumps. In contrast to the Olympic performance, in this study, all 3 jumps made by the athlete were considered, given the distance between the toe of the feet before jumping and the toe of the back foot in the case where the athlete landed with one foot in front of the other, after landing.

After the test was performed, the athlete was offered 2 folded tickets and asked to choose one, explaining that he would find 2 numbers, 0 and 1, and that he would not be told whether he would be in the treatment or control group, so as not to influence him, thus avoiding the placebo/nocebo effect (0 = No treatment, 1 = Yes treatment).

After the athlete selected the card, if he was in the treatment group, he was subjected to the treatment described in the previous chapter. Otherwise, it was subjected to placebo treatment that consisted of mild manipulations without any intention.

Following the treatment, the athlete was asked to perform a test leap, and after the test leap, the test characterized by measuring the three leaps was performed.

3. Results

The study showed a significant improvement in the distance in the standing long jump (**Figure 6**), which as a percentage translates into an increase of 3.67% (**Figure 7**) with $p < 0.01$ in the group undergoing fascial treatment, while the control group showed a worsening in distance (**Figure 6**), which as a percentage translates into a decrease of 1.119% with $p < 0.01$. The decrease is compatible with muscle fatigue caused by attempts made during the pre-treatment assessment phase. However, if we consider the decrease in physiological fatigue present in the control group, it is possible to hypothesize that the fascial treatment produces a greater increase than that shown, a reduced improvement from muscle fatigue to which even the athletes in the treatment group, went against.

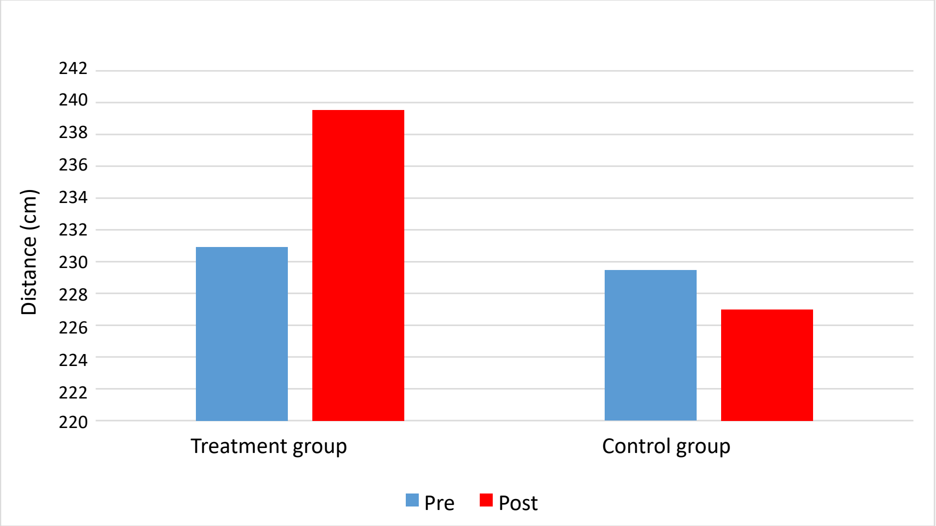

Figure 6. Difference in change of jump distance, expressed in cm, between treatment and control group.

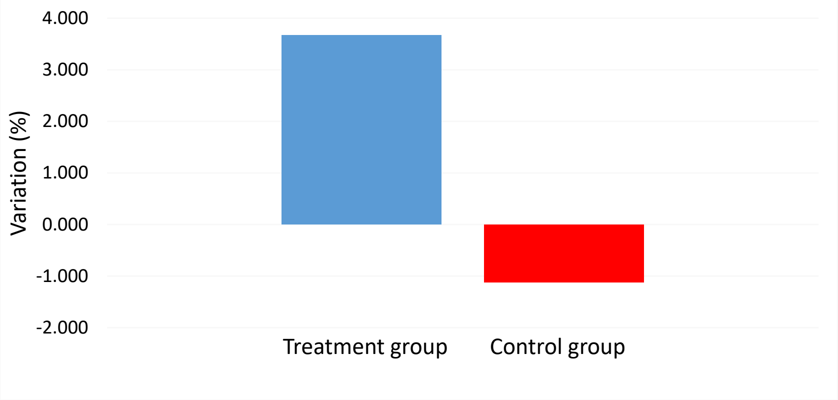

Figure 7. Change in performance, expressed as a percentage, between the treatment group and control group.

4. Conclusion

The study demonstrates that the bones of the lower limbs, thanks to specific manipulative treatments, change the elasticity of the bone tissue, with resultant improvements in the standing long jump performance.

5. Discussion

The scientific publication in question presents interesting experimental research that focuses on the elastic deformation of the bones in the lower limbs during athletic tests. The main objective of the research is to verify if manual treatment of bone tissue can increase the elasticity of the bones, allowing for more energy to be accumulated during the loading phase and released during the final push phase.

The results obtained from the research demonstrate a significant improvement in athletes' performance, thanks to the increase in bone elasticity achieved through manipulative treatment. This means that manual treatment of bone tissue is able to improve the functionality of treated structures, particularly in the field of sports.

It is important to underline how the research represents an important contribution to the world of sports medicine, as it offers new opportunities to improve athletic performance and prevent injuries. Additionally, the results obtained from the research could also be used in a rehabilitative context.

However, as with any scientific research, this one also presents some limitations. In particular, the sample of athletes examined is relatively small, albeit statistically significant, and limited to a single type of athletic test. Therefore, further studies on a larger sample of athletes and different types of athletic tests would be necessary to confirm the results obtained and evaluate their applicability in a broader context.

In conclusion, the research presented offers important food for thought for sports medicine and represents a step forward in understanding the effect of manual treatment on bone tissue. We are confident that these results will contribute to the development of new strategies to improve athletic performance and prevent injuries, benefiting both professional athletes and sports enthusiasts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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