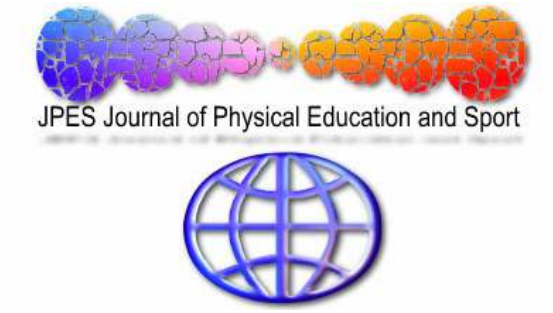

BIOMECHANICAL STUDY OF RISK FACTORS INVOLVED IN THE OCCURANCE OF PATELLAR TENDONITIS – APLICATIONS IN PERFORMANCE SPORT

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Abstract

Aim – this study consists in the constructing of a tridimensional musculoskeletal model for the attack hit and the quantification of mechanical stress, in order to prevent traumatism in the knee joint.
Goal: Minimizing the risk of patellar tendonitis through prophylactic exercises that improve the muscular pattern.
Material and methods. This study was conducted for a 9 month period on the feminine batch pertaining to the volley team of the Sport Club "Universities Craiova". For this research we used the AMTI MSA 6 force platform and the software application "Anybody". By using the force platform AMTI MSA 6 it became possible to determine the reaction force of the ground according to the position of the centre of gravity at the time of the jumping and landing, after executing an attack hit. The software "Anybody" allowed the 3D musculoskeletal modelling and the calculation of the forces of the muscles involved, prior and after the application of the prophylactic exercises.
Conclusions. The improvement of the values of muscular forces demonstrates the efficiency of the prophylactic exercises: for the quadriceps femoris we obtain an increase of 13,79%, for gastrocnemius 14,76%, for hamstring muscles a value of 14%, for rectus femoris 15,06% and for the gluteus major 14,63%.
For the entire experimental batch, at the moment of jumping, there was a reduction of the compression force by 38,48% for the dominant inferior limb, by 34,06% for the non-dominant inferior limb.
At the moment of landing, there was a difference of 38,51% for the dominant limb and a difference of 28,82% for the non-dominant limb. By analyzing the evolution of compression forces, after Z, at the level of knee joint, after the application of prophylactic program. We find a decreasing of pressure forces by a better distribution of this force for the entire inferior limb joint, decreasing in this way the risk of trauma production by overtraining.
Key words - risk factors, prevention, patellar tendonitis

Introduction

Epidemiological researches have shown that the athletes, participant in different sport area, are expose to different trauma based on particular factors for each sport and implied athlete. The ability of preventing this trauma depend on the capacity of understanding the trauma patterns and the intrinsic and extrinsic risk factors that are implied and also the possibility to realise an complex analyse of the execution technique characteristic for each sport branch.
For un sport where it is not present direct contact with the adversary, the volleyball determine an considerable stress on various body parts of the athletes, the most exposed to trauma are the shoulder, knee and ankle. In particular, the volleyball athletes expose the knee articulation to a mechanical and physiological stress that can lead to an acute traumatic stress and overtraining. Overtraining traumas that emerge after the performance volleyball can be connected with the impact force, impact rate and the athlete number of year of participation in competitions.
The study purpose consists in the construction of a muscular-skeletal tri-dimensional pattern for the strike attack and the quantification of mechanical challenge, to prevent over-stress trauma production in the knee joint.
Objective – Minimize the risk to produce patellar tendonitis by improving the muscular pattern based on the prophylactic exercise program.

Materials and methods

The present study was realised on a team of girls, components of volleyball team from University Craiova, for 9 months periods. The prophylactic proposed program was performed in the training field (The Sport Arena from Craiova, where the training and the officials games are currently conducted) and the kinetic determination where

realised at the Research Centre of the Faculty of Physical Education and Sport from the University of Craiova.

Research methods

a) Kinetics measurements using force platforms **AMTI MSA 6**

The calculation of reaction force of the soil to the weight centre and the reaction with the soil at the level of the weight centre during the jump and the landing, after the strike attack, by using the force platform for the entire group of subjects and were realised at the Research Centre of the Faculty of Physical Education and Sport from the University of Craiova. The values were register at the beginning of the study and after the prophylactic exercise program.

The athletes performed three sequences of the strike attack – the take off, the jump and the landing moments - on the force platform. Were register three execution for each subject. The data regarding the reaction of the soil and the pressure centre of the subjects were record with AMTI MSA 6 platform. An amplification system with a laptop and an analogue system of data acquisition A/D convertor la 16 bits resolution was use. The force platform measure the forces of soil reaction and the moments on the vertical axes, antero-posterior and medio-lateral, the rotation moment after the three axes, by time function, considerate to take action inside the pressure centre of the subject and the position of pressure centre of the subject, function of time, regarding the platform centre.

The trajectory of the weight centre of the subject is specifically characterized in quantitative terms, by rapport to the position of weight force exercise by the plantar surface against the support surface. To realise the quantitative calculus for the weight centre of the subject, was necessary to know the position of the two feet given the force platform, and also the dynamic relation (amplitude and frequency activity phase) between the forces centre and the weight centre dimension.

a) The tridimensional musculoskeletal model of the strike attack using **„Anybody" system.**

We used the **„Anybody" system** to establish the values for the regarding muscles, before and also at the end after the application of the prophylactic program during training sessions.

The ,,Anybody" software permit the calculation of the muscular force value, in Newton function by time by second. The innovation for this system consist in the fact that registration of those parameters can be realize in dynamic, during the execution of the attack hit by the athlete.

„Anybody" can determine automat the medium for the muscular values without statistical complex calculations.

Initially it will be realize a muscular-skeletal pattern with Anybody program that include tridimensional geometrical patterns for the subject bones, with insertion muscular points, with muscular models and the equation for actions of those muscles.

The „Anybody" software permit the performing of an tridimensional musculoskeletal pattern for one athlete woman, pattern the after that was adopted for the all the subjects. The pattern was after adapted for the rest of the subjects, by using the anthropometric data for each subject.

The application of this pattern is the prevention of patellar tendonitis.

To attain of the prevention intend purpose, the patellar tendonitis, trauma with a high frequency in volleyball game, we conceive an kinetic exercise program to improve muscular training process for the lower limb and training to keep the player group most homogeneous, without muscular trauma, to increase the computational technical-tactical efficiency level of the team and players.

The prophylactic exercise patterns propose to assure the development of muscular force and the equilibrium between the agonist and antagonist muscles, with favourable effects to improve the most important parts of sport preparation, with an important role in prevention of the trauma that can affect the lower limb.

The prophylactic program for patellar tendinitis has the purpose/objective to improve the force and flexibility of posterior calf and a quadriceps by exercises that follow the next criteria.

1. Training the extensor mechanism of the knee (vastus lateralis, medialis, intermedius, quadriceps femoris) to resist to intense and repetitive forces during the concentric and eccentric jumps;
2. The training of gastrocnemius muscles and flexors of the shank, with important role in the landing phase of the vertical jump.

The propose model was applied on a period of a annual macrocycle, choosing, grouping and measurements of the means was realized by keeping in mind the division into periods of the sport training and principals objectives desire for. During the preparation period the prevention program was applied with a frequency of 3 time a week, during the pre-competition and competition periods with two times a week frequency.

The time allocate for the programs, during the training, was 15 minutes from which 4 minutes for the warm-up to improve the mobility of joint knee, also the muscular flexibility and 11 minutes at the ending of the training session in order to develop the muscular force.

The stretching exercises were included in the first part of the training session, in warm-up period, and the exercises of the enhancing the muscular force in the last period of the session, before the period necessary for the organism to recover after effort.

During the experiment proceeding we do not modify the structure of the regular training, the training follow the

program and planning already establish for each period of preparation.
Carry on of the training session was realized in optimal conditions because of the good collaboration between the trainer and the players. Before the application of the program, the subjects were teaching regarding the program and exercises succession.
After the application of the experimental program, the cinematic tests were carrying on to reassessment the parameters initial determinate. The tests were developing in similar condition with the initial determination using the same category of indices.

Results
For each athlete, using Anybody system we determine the next data:
-the muscular forces by time, rate from the maximal muscular force for the principal muscles from the knee articulation, in the moment of soil.... and landing, after performing the strike attack.
-the compression forces Fz at the knee articulation level.
Figure 1. (a,b,c) represent an diagram of the solicitation for the Anybody original model: a) anterior view, b) posterior view, c) lateral view.

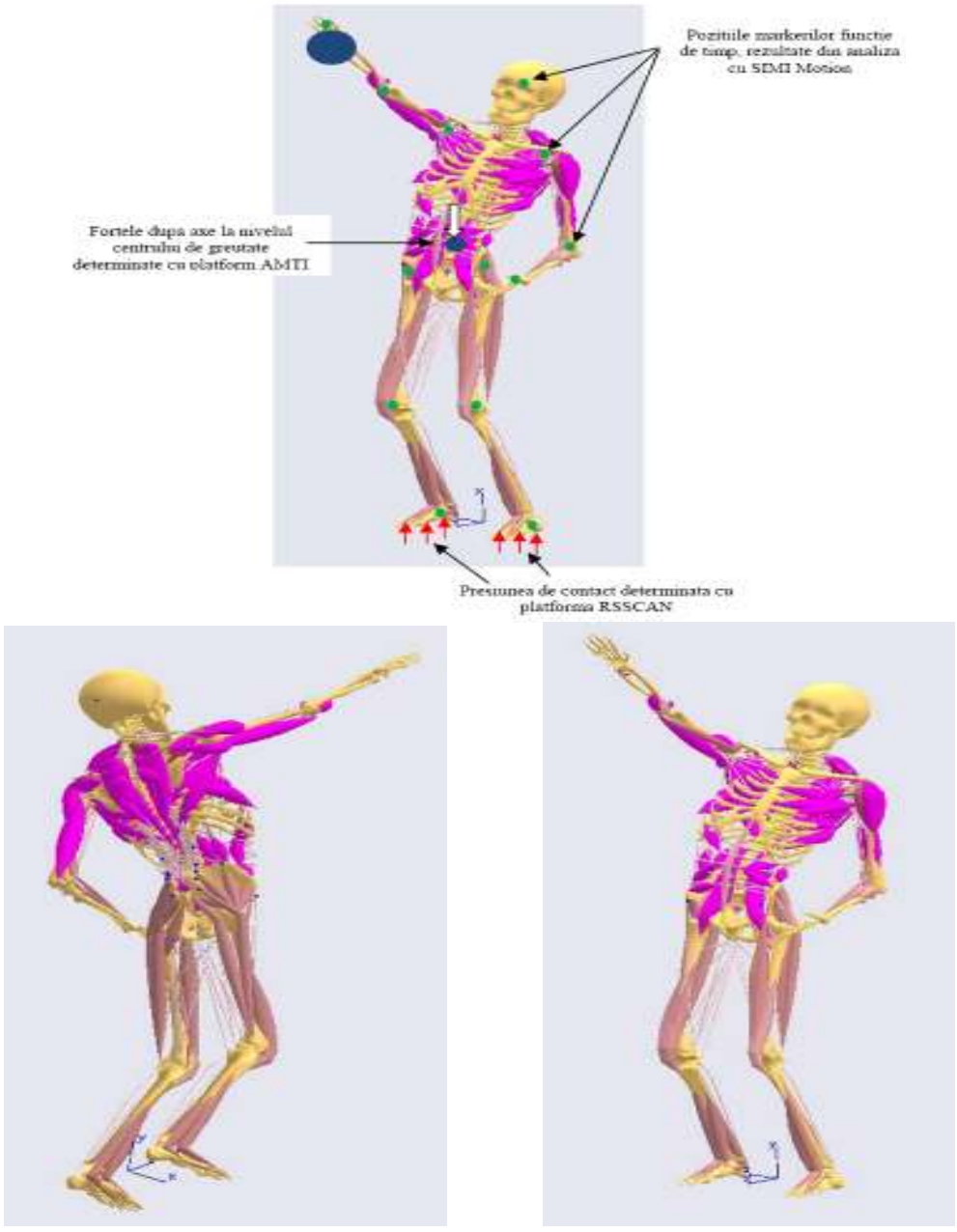

Fig. 1.(a,b,c). The original Anybody model realised inside of this article. (The original Anybody model elaborated within this research)

The original realized Anybody model can be modified for each athlete, in conformity with his available anthropometrical data and contain muscular kinetic specific equations for the joints.

The evolution of muscular forces, for the lower limb, in the experimental group, after the application of prophylactic program.

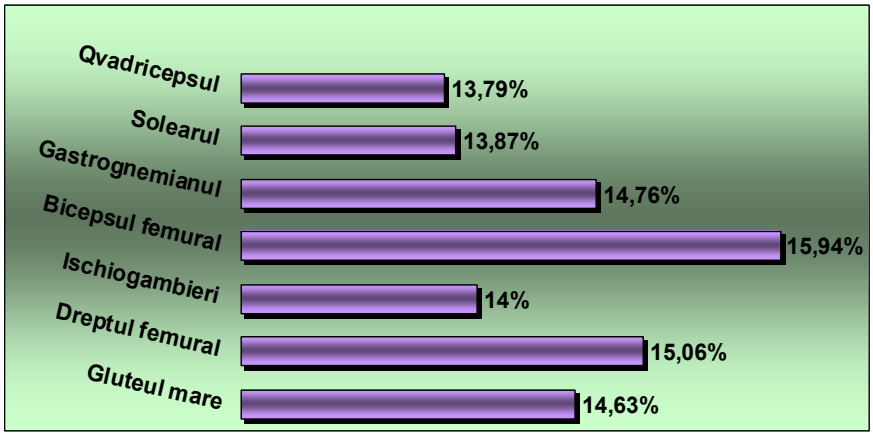

Fig. 2. The arithmetic medium (in percent) progresses registered in the experimental group for the forces of the muscular groups for the lower limbs, after application of the prophylactic program.

Arithmetical average (in percentage) of registered progresses in the experimental group, for muscular forces at the lower limbs level, after applying the proposed prevention program

The progress recorded by the experimental group for the analysed muscular forces at the dominant lower limb level, during the strike attack, shows the improvement of muscular forces for all analyzed muscles.

Because the aimed purpose of the present study consisted in maintaining a constant muscular force during the whole yearly macrocycle, aiming to prevent in this way the appearance of injuries for the experimental group, the efficiency of the proposed program is showed by the improvement of the muscular values.

The most significant increase was recorded for the biceps femoralis muscle, with a pecentage of 15,94%, and the lowest for solearis muscle with a pecentage of 13,87%.

The muscular forces for the other analysed muscles were limited betwen the 2 percentage values, recording the following values:

Quadriceps femoris - 13,79%
Gastrocnemius – 14,7
Hamstrings muscles – 14%
Rectus femoris– 15,06%
Gluteus major – 14,63%

Measurements of compression forces for the knee joint

Based on the forces at the level of the weight center determine with the AMTI force platform. Were calculated the compression forces Fz at the level of knee joint for all 12 subject analyzed, at the beginning and at the end of the prophylactic program.

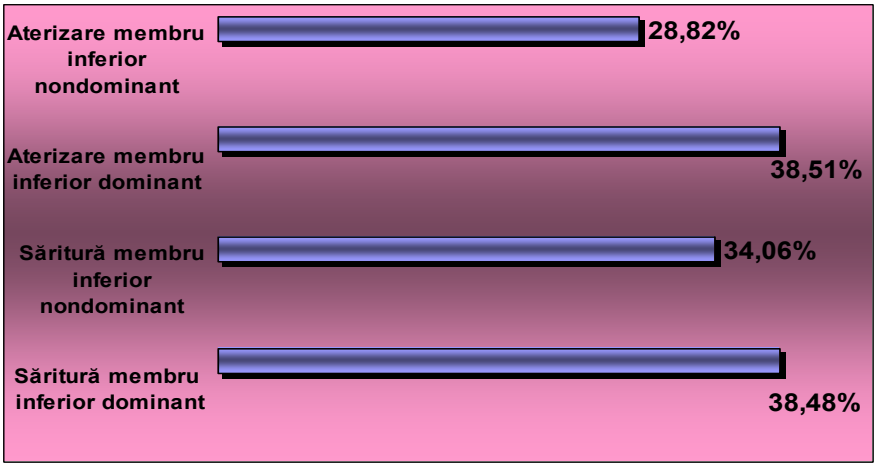

Fig. 3. Arithmetical average (in percentage) for the evolution of force after Z, at the knee joint level for the experimental group, after application of the prophylactic program.

Analysing the compression forces after Z at the knee joint level in the dominant and non-dominant lower

limb, for the experimental group after application of the preventional programme we observed a decrease of the pressure values, atributed to a better pressure distribution in all the joints of the loweer limb, decreasing in this way the risk of oberuse trauma production.

For the whole experimental group in the moment of jump we registered a decrease in the compression force with a percentage of 38,48%, for the lower dominant limb and of 34,06% for the lower non-dominant limb.

In the moment of landing we obtained a difference of 38,51% for the lower dominant limb and a difference of 28,82%, for the lower non-dominant limb.

Discussion and conclusions

The vertical jumps are characterized by the stretch-shortening cycle of the muscular activity, that give big forces over the extensor mechanism of the knee, booth in the concentric phase also in the eccentric phase, over-challenging repetitively the patellar tendon, predisposing to trauma.

The joint reaction phase at lower limb level, this is bigger in the moment of landing then in the jump execution moment. In the moment of landing, the athlete's incapacity to distribute the kinetic energy accumulated during the jumping moment is a risk factor to produce the overuse patellar tendonitis.

The propose prophylactic pattern for the patellar tendonitis for the volleyball athletes, centred on the increasing of the force and the flexibility of posterior muscular group, also the distribution of the forces at joint level, proving the efficiency and applicability into practice.

The experimental pattern we propose, assure the development of the muscular force and un equilibrium of the ratio between the agonistic and antagonistic muscle, with favourable effects in improving the most important parts of sport-athletic preparation, with an demonstrated role in trauma prevention that affect the lower and upper limb.

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L'ETUDE BIOMECHANIC DU FACTEURS DU RISC ENGAGER COMPORTE DANS LA PRODUCTION DU TENDINITE PETTELAIRE - APLICATIONS DANS LE SPORT DU PERFORMANCE

Résumé: Le scope du cet étude est du construire un tridimensionnel model du muscle et du squelette pour le mouvement du frappe d'attaque de volleyball et la déterminassions des mécaniques sollicitations pour obtenir la prévention du trauma a cause du over-training dans l'articulation du genou.

Le but. La réduction du risque de la production de la tendinite patellaire en améliorant le pattern musculaire avec un programme prophylactique d'exercices.

Matériels et méthodes. L'étude a été réalise pour le lot de l'équipe du Club Université Craiova, pour une période de 9 mois. Durant la recherché nous avons utilise une plateforme du force AMTI MSA 6 qui a permis l'évaluation du force de réaction du sol en fonction du la réaction du centre du poids pendant le moment du saut et le moment du atterrissage, après la frappe d'attaque. Il software „Anybody" a permis le modelaje, computerise 3D musclé-squelettique et le calcul des valeurs du forces pour les muscles intéresse, avant et après l'application du programme kinésique propose pour la prévention de la tendinite patellaire.

Conclusion. L'amélioration des valeurs de forces musculaire prouve l'efficience du programme kinésique prophylactique : pour le muscle quadriceps avec 13,79%,, pour le gastrocnemian 14,76%, pour les muscles postérieurs du cuisse 14%, pour le droit fémoral 15,06% et pour le grande gluteus 14,63%.

Pour le complet lot de sportives, dans le moment du saut, il a été registre une réduction de la force de compression avec un pourcentage du 38,48% pour le membre inférieur dominant, et pour le membre inférieur non-dominant avec un pourcentage du 34,06%. Pour le moment de l'atterrissage, on a obtenu une différence de 38,51% pour le membre inférieur dominant et une différence de 28,82% pour le membre inférieur non-dominant.

En faisant la analyse du forces de compression, après Z, au niveau de l'articulation du genou, après l'application du programme prophylactique on note une diminuassions du valeurs des pressions a cause d'une meilleur distribution des forces dans touts les articulations du membre inferieur, en réduisant le risque de la production du trauma a cause du over-training.

Motsclé – facteurs du risque, prévention, patellaire tendinites