EVALUATION OF THE PATELLAR HEIGHT IN ATHLETES DIAGNOSED WITH CHRONIC TENDINOPATHY OF THE KNEE EXTENSOR MECHANISM

EMERSON GARMS, ROGÉRIO TEIXEIRA DE CARVALHO, LEONARDO ADDEO RAMOS, JORGE SAYUM FILHO, MARCELO MITSURO MATSUDA, MOISÉS COHEN

ABSTRACT

Objectives: To carry out a radiographic evaluation of patellar height in athletes diagnosed with chronic tendinopathy of the knee extensor mechanism; Methods: Radiographic assessments were carried out on 65 patients (110 knees) aged between 15 and 40 years, who practiced different kinds of sports, some with of chronic tendinopathy of the knee extensor mechanism (jumper's knee) and others without. The athletes were divided into two groups: those with diagnosed "jumper's knee" (group 1:38 athletes - 56 knees) and a control group (group 2:27 athletes – 54 knees). In group 1, 18 of the athletes presented the condition in both knees on examination. The height of the patella was measured using the Insall-Salvati and Blackburne-Peel x-ray methods. Conclusion: The presence of a high patella in the group of athletes with chronic tendinopathy of the knee extensor mechanism was significantly higher than in the control group.

Keywords: Evaluation. Tendinopathy. Knee. Athletic injuries.

Citation: *Garms E, Carvalho RT, Ramos LA, Sayum Filho J, Matsuda MM, Cohen M. Evaluation of the patellar height in athletes with diagnosed with chronic tendinopathy of the knee extensor mechanism. Acta Ortop Bras. [online]. 2011;19(1):17-21. Available from URL: http://www.scielo.br/aob.*

INTRODUCTION

Chronic tendinopathy of the knee extensor mechanism (jumper's knee) is one of the frequent disorders of the knee in athletes that regularly practice some sport activity. At competitive or recreational levels, it can entail lesions and temporary suspension of activities for the athlete. This ailment is clinically defined as a condition of chronic overburdening of the knee extensor mechanism, resulting from repetitive traumas. The patient presents previous pain in the knee that generally improves with rest, and that reappears with sports activity.[1,2] The high incidence of tendinopathy of the patellar tendon in volleyball athletes dates back a long way.[3] The name "jumper's knee" adds injury to the quadriceps tendon and aids in the classification of tendinopathies of the extensor mechanism in terms of the stage of impairment.[4]

One of the hypotheses for genesis of the lesion is the repetitive friction between the apex of patella and posterior surface of the patellar tendon related to movements with deceleration and braking, and not only to jumping as described previously.[3,4] Certain sports that involve repeated movements such as kicking, running, jumping, repeated flexions and knee rotation can present factors that favor the appearance of the lesion.

In patients who do not practice any sports activity, the intrinsic factors considered conducive to injury such as: increase of quadriceps angle (Q), changes of patellar height, external tibial torsion, internal femoral torsion, femoropatellar instabilities, foot pronation, etc.[5] In athletes, particularly, due to the repeated actions of the sport, change of patellar height is an underlying factor of lesion appearance, as the articular biomechanics in these cases are impaired.[6]

The association between high patella and chronic tendinopathy of the knee extensor mechanism, besides being an underlying factor, also causes symptoms and damage in the athlete's knee even after the end of their sports career.[7]

The objective of this transversal study consists of a radiographic evaluation (views: anteroposterior and lateral at 30 degrees) of patellar height in athletes with chronic tendinopathy of the knee extensor mechanism.

MATERIALS AND METHODS

This transversal study was conducted in the period between January 2006 and July 2007 and was approved by the

All the authors declare that there is no potential conflict of interest referring to this article.

Universidade Federal de São Paulo

Study conducted in the Sports Traumato-Orthopedics Center (CETE) of the Department of Orthopedics and Traumatology of Universidade Federal de São Paulo (UNIFESP/EPM). Mailing Address: Rua Embaú 87, Vila Clementino, São Paulo, SP, Brazil. CEP: 04039-060. E-mail: egarms@uol.com.br

Article received on 1/9/09 and approved on 1/22/10.

Institutional Review Board. The athletes were divided into two groups: those with diagnosis of chronic tendinopathy of the extensor mechanism, denominated study group (group 1: 38 athletes - 56 knees) and a control group (group 2: 27 athletes, 54 knees). The sample presented 65 athletes (110 knees), with age ranging between 15 and 36 years (26.1 ± 5.5 years) in the control group and from 20 to 40 years (26.7 ± 5.6 years) in the study group. All the athletes were involved in regular sports activities, with twenty-eight practicing athletics, nine soccer, five basketball, five bodybuilding, five volleyball, four handball, two table tennis, two softball, two karate, one taekwondo, one swimming and one capoeira.

The patients both from group 1 and from group 2 were amateur athletes with a training routine of two hours per day, on average, three times a week, excluding championships. Group 1 was formed by 38 patients with a diagnosis of chronic tendinopathy of the knee extensor mechanism, while 18 of them exhibited bilateral impairment. The diagnosis was clinical and by imaging (radiographies, ultrasonography and magnetic resonance). All the athletes included in the study had a history of pain in the knee extensor mechanism lasting for more than one month and of progressive nature. The pain location was determined by painful palpation of the apex of patella, body of the quadriceps tendon or at the insertion site of the patellar tendon in the tibial tuberosity, pursuant to a technique described previously.[3] The palpation exam was carried out by the same examiner (E.G.). Group 2, the control group, was formed by 27 athletes without any kind of complaint of pain in the knee region. Athletes who presented a previous history of knee injury documented by imaging exams (radiographies), types of osteochondritis such as Osgood-Schlatter disease, calcifying tendinitis, or those that have been submitted to surgical treatment of the knee, were excluded from the study. A radiographic evaluation was conducted on 110 knees, with 56 in the study group and 54 in the control group. The data on the study group are presented in Table 1.

The diagnosis of chronic tendinopathy of the knee extensor mechanism was clinical history and pain on palpation at the lower pole of the patella, patellar tendon or insertion of the quadriceps tendon. For the performance of the patellar height measurements, radiographies were taken with a lateral view of the knees with flexion of 30°, pursuant to the technique mentioned previously.[4] (Figures 1-2) The patellar height was measured by the same examiner, according to two methods: one described by Insall and Salvati apud Roels *et al*.[4] and another by Blackburne and Peel,[8] having values above 1.2 and 0.96, respectively, as a reference to establish high patella.[4,8]

The statistical analysis was performed with a comparison of the groups, using the Student's t-test and the Chi-Squared test for this purpose, with $p<0.001$.

Table 1. *Data on type of sport and site of chronic tendinopathy of the extensor mechanism in athletes from the study group.*

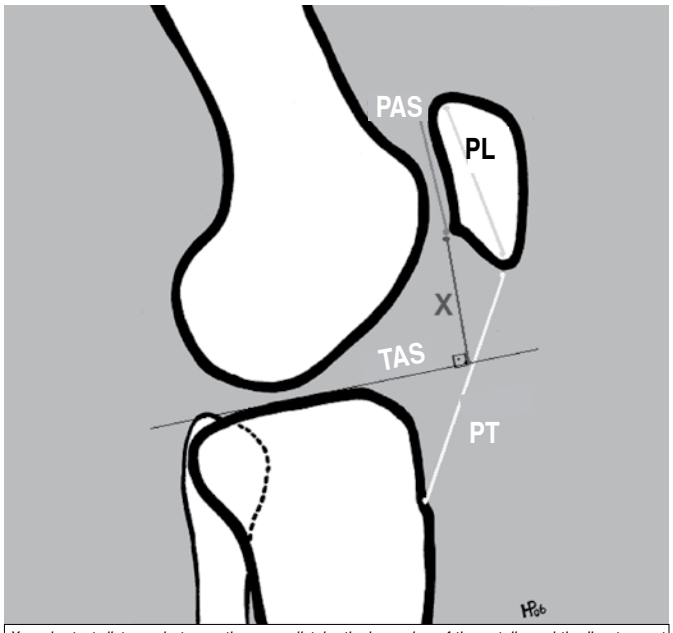
ATHLETE (GROUP 1)	SPORT PRACTICED	SITE AFFECTED
1	Athletics	U - AP
2	Basketball	BI- AP
3	Soccer	U - AP
4	Basketball	BI - AP
5	Athletics	BI - AP
6	Athletics	BI - AP
7	Athletics	BI - AP
8	Athletics	BI - AP
9	Basketball	BI - PL
10	Volleyball	BI - QT + AP
11	Athletics	BI - AP
12	Athletics	U - AP
13	Volleyball	U - PL
14	Athletics	U - AP
15	Bodybuilding	BI - QT + AP
16	Volleyball	BI - PL
17	Athletics	U - QT + AP
18	Athletics	U - AP
19	Softball	BI - QT
20	Table Tennis	U - QT
21	Athletics	U - AP
22	Handball	U - AP
23	Taekwondo	U - AP
24	Bodybuilding	U - AP
25	Soccer	U - AP
26	Athletics	U - AP
27	Athletics	BI - AP
28	Soccer	U - AP
29	Athletics	U - PL
30	Bodybuilding	U - AP
31	Capoeira	BI - AP
32	Athletics	BI - QT
33	Athletics	U - AP
34	Athletics	U - AP
35	Handball	BI - AP
36	Soccer	U - AP
37	Handball	BI - AP
38	Athletics	BI - AP

BI: bilateral; U: unilateral; AP: apex of patella; PL: mid portion of the patellar ligament; QT: quadriceps tendon.

RESULTS

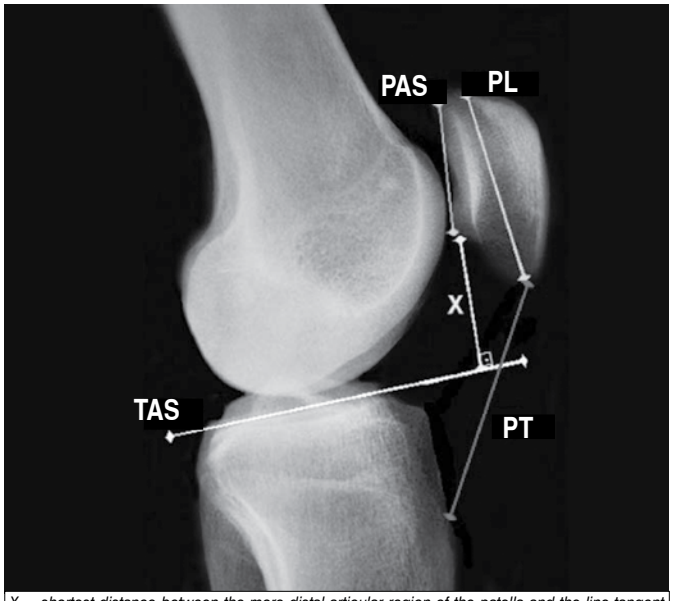
In the study group, 17 (30.4%) knees presented normal patellar height in the two ratios, six (10.7%) knees presented high patella by the Insall-Salvati ratio and normal by the Blackburne-Peel ratio, 13 (23.2%) knees presented normal patellar height by the Insall-Salvati ratio and presence by the Blackburne-Peel ratio and 20 (35.7%) knees presented high patella in the two ratios. Therefore in the study group 39 (69.6%) knees were obtained with high patella determined by at least one of the two ratios used.

In the control group, 42 (77.8%) knees presented normal patellar heights in the two ratios, three (5.6%) knees presented high patella by the Insall-Salvati ratio and normal by



X = shortest distance between the more distal articular region of the patella and the line tangent to the articular surface of the tibial plateau; TAS = line tangent to the articular surface of the tibial plateau; PAS = length of the articular surface of the patella; PL = longest longitudinal length of the patella; PT = length of the patellar tendon

Figure 1. *Method for measurement of the Insall-Salvatti (PT/PL) and Blackburne-Peel (X/PAS) ratios in an illustrative diagram of the knee in lateral view.*



X = shortest distance between the more distal articular region of the patella and the line tangent to the articular surface of the tibial plateau; TAS = line tangent to the articular surface of the tibial plateau; PAS = length of the articular surface of the patella; PL = longest longitudinal length of the patella; PT = length of the patella tendon.

Figure 2. *Method for measurement of the Insall-Salvatti (PT/PL) and Blackburne- Peel (X/PAS) ratios in an illustrative diagram of the knee in lateral view.*

the Blackburne-Peel ratio, 7 (13%) knees presented normal patellar heights by the Insall-Salvati ratio and presence by the Blackburne-Peel ratio, and two (3.7%) knees presented high patella by both ratios. Thus 12 (22.2%) knees were obtained in the control group with high patella determined by at least one of the two ratios used.

The comparative data of the patellar heights are presented in Tables 2 and 3.

The groups appeared homogeneous in terms of gender and age ($P>0.05$ in both comparisons).

The mean patellar height of the study group, evaluated by the Insall-Salvati ratio, was significantly higher than the mean value of the control group ($p<0.001$), 1.175 ± 0.162 and 1.063 ± 0.104 respectively.

The study group presented high patella, according to the Insall-Salvati ratio, significantly greater than the control group ($p<0.001$), with 46.4% of presence in the study group and 9.3% in the control group.

The mean patellar height of the study group, evaluated by the Blackburne-Peel ratio, was significantly greater than the

Table 2. *List of athletes diagnosed with chronic tendinopathy of the extensor mechanism (Group 1) in relation to the patellar height measurements verified.*

Athlete	Age	Gender	Activ.	Site	IS (R)	BP (R)	IS (L)	BP (L)
1	20	M	A	AP	1.21	0.97	NR	NR
2	24	M	B	AP	1	1	1.1	1.4
3	22	F	B	AP	1.27	1	1.3	1.1
4	21	F	SOC	AP	NR	NR	1.18	1.13
5	22	F	A	AP	0.9	0.9	0.8	0.9
6	21	M	A	AP	1.4	1.1	1.3	1.1
7	39	F	A	AP	1	1	1	1
8	24	M	A	AP	1.2	0.9	1.1	1
9	21	M	B	PL	1	1	1	1.3
10	23	F	V	QT+AP	1.23	0.8	1.3	0.9
11	24	M	A	AP	1.5	1.2	1.4	1.2
12	20	M	A	AP	0.9	0.8	NR	NR
13	23	F	V	PL	1.4	0.8	NR	NR
14	34	F	A	AP	1.23	0.8	NR	NR
15	28	M	BO	QT+AP	1.22	0.93	1.22	1.06
16	23	M	V	PL	1.35	1.06	1.16	1.03
17	29	M	A	QT+AP	NR	NR	1.06	1.06
18	30	F	A	AP	NR	NR	1.06	1.3
19	36	F	SO	QT	1.2	0.86	1.13	0.93
20	26	M	TT	QT	NR	NR	1.37	1.5
21	40	F	A	AP	NR	NR	1.37	1
22	23	F	H	AP	NR	NR	1.44	1.14
23	25	M	TK	AP	NR	NR	1.4	1.03
24	28	F	BO	AP	NR	NR	1.16	0.8
25	30	M	SOC	AP	NR	NR	1	0.86
26	33	M	A	AP	NR	NR	0.91	0.84
27	25	M	A	AP	1.08	0.9	1	0.83
28	21	M	SOC	AP	NR	NR	1	0.93
29	23	M	A	PL	1	0.89	NR	NR
30	25	F	BO	AP	NR	NR	1.25	0.86
31	28	M	C	AP	1.13	1.25	1.11	1.11
32	40	M	A	QT	1.27	1.07	1.22	1.03
33	30	M	A	AP	1.42	1.1	NR	NR
34	22	F	A	AP	NR	NR	1.25	1.06
35	28	F	H	AP	1.42	1.05	1.27	1.02
36	23	M	SOC	AP	NR	NR	1.25	1.06
37	27	F	H	AP	1.07	0.93	1.02	0.83
38	34	F	A	AP	1.1	0.7	1.17	0.85

AGE (in years); ACTIV- activity: A: athletics, B: basketball, C: capoeira, SOC: soccer, H: handball, S: surf, SO: softball, BO: bodybuilding, TT: table tennis, TK: taekwondo, V: volleyball; Site- site affected by tendinopathy: AP: apex of patella; PL: mid portion of the patellar ligament; QT: quadriceps tendon; IS-R: Insall-Salvati ratio right knee; IS-L: Insall-Salvati ratio left knee; BP-R: Blackburne-Peel ratio right knee; BP-L: Blackburne-Peel ratio left knee.

Table 3. *List of athletes without diagnosis of chronic tendinopathy of the extensor mechanism (Group 2) in relation to the patellar height measurements verified.*

Athlete	Age	Gender	Activ.	IS (R)	BP (R)	IS (L)	BP (L)
1	25	F		1	0.5	0.9	0.7
2	22	F	A	1.1	0.8	1.25	0.6
3	21	M	A	1	0.	1.1	0.8
4	23	M	B	1.21	0.8	1.3	0.9
5	22	M	A	1	1	1	0.5
6	19	F	SOC	1.1	1.1	1.1	0.8
7	30	M	SOC	1.12	0.9	1.13	0.89
8	22	M	SOC	1.04	0.93	0.97	0.96
9	36	M	A	1.06	1	1.08	1
10	22	M	A	1.12	0.91	1.18	0.86
11	23	F	H	1.19	0.96	1.14	0.96
12	33	F	A	1.11	0.93	1.09	0.87
13	27	M	SW	0.95	0.82	0.95	0.73
14	33	M	SOC	1	0.93	0.96	0.87
15	25	M	A	0.9	0.86	0.83	0.91
16	22	F	V	1.08	1.08	1	0.92
17	22	F	BO	1.13	0.96	1.18	0.93
18	35	M	K	1.02	1.03	1	0.96
19	24	M	TT	1.13	0.94	1.15	0.94
20	23	M	B	1.06	0.87	1.04	0.87
21	34	M	A	0.95	0.85	0.93	0.81
22	33	M	BO	0.9	1.08	0.91	0.94
23	15	F	SOC	1.11	0.86	1.06	0.89
24	29	M	A	1.16	0.72	1.16	0.67
25	30	M	A	1.22	1.2	1.24	1
26	32	M	K	1.11	0.87	1.13	0.96
27	23	M	S	0.91	0.92	0.96	0.94

AGE (in years); ATIV- activity: A:athletics; B: basketball, C: capoeira, SOC: soccer, H: handball, K: karate, S: surfing, M: bodybuilding, SW: swimming, TT: table tennis, V: volleyball; Site- Site affected by the tendinopathy:; IS-R: Insall-Salvati ratio right knee; IS-L Insall-Salvati ratio left knee; BP-R: Blackburne-Peel ratio right knee; BP-L: Blackburne-Peel ratio left knee.

Table 4. *Statistical evaluation.*

Variables	Study Group (n=56)	Control Group (n=54)	Comparison
Patellar Height – Insall and Salvati			
Mean ± sd	1.175 ± 0.162	1.063 ± 0.104	$p1 < 0.001^*$
Minimum - Maximum	0.80 – 1.50	0.83 – 1.30	
High patella – Insall and Salvati – n (%)			
Normal	30 (53.6)	49 (90.7)	$p2 < 0.001^*$
Present	26 (46.4)	5 (9.3)	
Patellar Height – Blackburne and Peel			
Mean ± sd	1.003 ± 0.159	0.883 ± 0.133	$p1 < 0.001^*$
Minimum - Maximum	0.70 – 1.50	0.50 – 1.20	
High patella – Blackburne and Peel – n (%)			
Normal	23 (41.1)	45 (83.3)	$p2 < 0.001^*$
Present	33 (58.9)	9 (16.7)	

*p_1: Student's T-test; p_2: Chi-square test

mean value of the control group ($p<0.001$), 1.003 ± 0.159 and 0.883 ± 0.133, respectively.

The study group presented high patella, according to the Blackburne-Peel ratio, significantly greater than the control group ($p<0.001$), with 58.9% of presence in the study group and 16.7% in the control group. (Table 4)

DISCUSSION

In previous studies on chronic tendinopathies of the knee extensor mechanism in athletes, scarce attention is paid to patellar height.[2-4] In our study we attempted to correlate patellar height with chronic tendinopathy of the extensor mechanism of athletes.

The diagnosis of chronic tendinopathy of the knee extensor mechanism in the athletes from our study was clinical, based on the history of pain in the knee extensor mechanism, of an evolutionary and limiting nature and related to overload activities.[1] Besides the history, the diagnostic evaluation was supplemented by the physical examination, which consisted of locating the site of the pain through palpation (apex of patella, quadriceps tendon, patellar tendon and/or patellar tendon insertion site in the tibial tuberosity).

In another study with seventeen adolescents diagnosed with Osgood-Schlatter disease, and twelve adolescents without pain in the anism and contrary to the abovementioned study, found a relationship between chronic tendinopathy of the knee extensor mechanism and high patella.

The relationship between patellar height and disorders of the extensor mechanism in youths (Osgood-Schlatter disease) was reported in a study with 40 soccer players (eighty knees) with follow-up of 2 years.[11] No athlete presented high patella prior to the occurrence of any kind of disorder of the extensor mechanism. Of the twelve athletes diagnosed with Osgood-Schlatter, during the follow-up, ten presented high patella after the onset of the symptoms. Therefore the authors concluded that high patella is a consequence of Osgood-Schlatter disease in immature athletes. In this study, the athletes diagnosed with Osgood-Schlatter disease were excluded, and it was not possible to evaluate the possibility of this correlation.

As regards the affected site, chronic tendinopathy of the knee extensor mechanism affected in order of frequency, the origin of the patellar tendon in the patella (apex) in 65%, the quadriceps tendon (upper patellar pole) in 25% and the patellar tendon 10% of times.[12] In a national study, the location of the pain at the apex of patella occurred in 63.8%, in the patellar tendon in 25.9%, in the quadriceps tendon in 6.9% and in the tibial insertion of the patellar tendon in 3.4% of the cases.[13] In this study, of the 56 knees diagnosed with chronic tendinopathy of the knee extensor mechanism, 46 presented pain at the apex of patella (73.7%), four in the patellar tendon (10.5%), three exclusively in the quadriceps tendon (7.9%) and three in the patellar and quadriceps tendon concomitantly (7.9%),

which is close to the values found in literature.

Chronic tendinopathy of the knee extensor mechanism can be evaluated by several imaging methods, which can be plain radiographies, ultrasonography, computed tomography and nuclear magnetic resonance. As regards the radiographic measurements, a simple radiographic study was executed. The two radiographic indices used in this study are described in other studies, although there are other indices for the determination of patellar height.[14,15]

In the determination of the *Insall-Salvatti* ratio it proved difficult to accurately locate the insertion of the patellar tendon in the anterior tibial tuberosity, as described previously.[16] In the calculation of the *Blackburne-Peel* ratio it was not necessary to locate this point of insertion of the patellar tendon. The measurement is based on the shortest distance between the more distal part of the patella and the line tangent to the articular surface of the tibial plateau. (Figure 1) There was no variation of this index in keeping with the degree of knee flexion.

When we studied the two indices, there was a significant statistical difference in the study group, in relation to the control group, supporting the findings of other studies, which observed an association between high patella and pain in the knee extensor mechanism.[9,11]

In this study there were limitations such as the failure in classifying the degree of tendon impairment, the period of evaluation in different stages of impairment and comparison of different sports. All the athletes that took part in the study completed and signed the informed consent.

CONCLUSION

In this study a direct relationship was observed between high patella and chronic tendinopathy of the knee extensor mechanism, which was demonstrated by statistical significance between the study group and the control group when studying patellar height by the *Insall-Salvatti* and *Blackburne-Peel* ratios.

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