



# Can Isokinetic Testing Lead to More Precise Monitoring of Chondromalacia Patella? Prospective, Cross-sectional Study

## İsokinetik Test, Kondromalazi Patellanın Daha Kesin Monitorizasyonunu Sağlayabilir mi? Prospektif, Çapraz-kesitsel Çalışma

İlknur Saral<sup>1</sup>, Hande Başat<sup>1</sup>, Mehmet Ağırman<sup>2</sup>, Esra Tekeci<sup>3</sup>, Engin Çakar<sup>4</sup>

<sup>1</sup>Bahçeşehir University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Turkey

<sup>2</sup>Istanbul Medipol University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Istanbul, Turkey

<sup>3</sup>Memorial Hospital, Clinic of Physical Medicine and Rehabilitation, Istanbul, Turkey

<sup>4</sup>Üsküdar University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Turkey

### ABSTRACT

**Objective:** Chondromalacia patella, one of the most common musculoskeletal problems encountered in clinical practice. The isometric test using the isokinetic dynamometer can be used for a valid assessment and follow-up of knee strength during the rehabilitation of chondromalacia patella. Our study investigates the effectiveness of the isokinetic dynamometer as a monitoring tool for individuals with chondromalacia patella.

**Methods:** Twenty-eight patients with chondromalacia patella (mean age 39±10.84 years, mean symptom duration 11.75±7.38 months) were included in the study. All patients had physical therapy and rehabilitation program that was applied for 15 sessions, 5 days a week during 3 weeks. Knee flexion and extension strengths were measured at 60°/second and 180°/second (5 sets) angular velocity with an isokinetic dynamometer system before and after physical therapy and rehabilitation program. Visual analog scale (VAS)-pain value was used for clinical assessment. Modified magnetic resonance imaging (MRI) staging system was used in the staging of chondromalacia patella. The relationship between VAS pain value and isokinetic dynamometer parameters was analyzed, as well as correlation in radiological MRI staging, treatment effectiveness, symptom duration. A value of p<0.05 was considered significant.

**Results:** Statistically significant improvement was observed in the knee flexion and extension muscle strengths at 60°/second and the 180°/second angular velocity (PTE\_60, PTF\_60, PTE\_180, PTF\_180) after the physical therapy and rehabilitation program in affected knees (p=0.0001 for all). Analysis of correlation and interaction of chondromalacia patella MR stages, VAS pain value, body mass index, duration of symptoms, and treatment efficacy was also statistically significant (p<0.05).

**Conclusion:** Our study results suggest that physical therapy and rehabilitation program improves the strength of both knee extensors and flexors, and isokinetic parameters have a significant effect on the treatment effectiveness. The isokinetic dynamometer may provide a precise monitoring to assess treatment efficacy of patients with chondromalacia patella. More studies are needed for further scientific evidence.

**Keywords:** Chondromalacia patella, muscle strength, the dynamometer, isokinetic testing, physical therapy and rehabilitation

### ÖZ

**Amaç:** Kondromalazi patella, klinik pratikte en sık karşılaşılan kas-iskelet sistemi problemlerinden biridir. İzokinetik dinamometre kullanılarak yapılan izokinetik testleme, kondromalazi patellanın rehabilitasyonu sırasında diz kuvvetinin objektif değerlendirilmesi ve takibi için kullanılabilir. Bu çalışma, kondromalazi patellalı bireylerde izleme aracı olarak izokinetik dinamometrenin etkinliğini araştırmayı amaçlamaktadır.

**Gereç ve Yöntem:** Kondromalazi patellalı olan yirmi sekiz hasta (ortalama yaş 39±10,84 yıl, ortalama semptom süresi 11,75±7,38 ay) çalışmaya dahil edildi. Tüm hastalara 3 hafta boyunca, haftada 5 gün, 15 seans fizik tedavi ve rehabilitasyon programı uygulandı. Program öncesi ve sonrası izokinetik dinamometre ile 60°/saniye ve 180°/saniye (5 set) açışal hızda diz fleksiyon ve ekstansiyon kas kuvvetleri ölçüldü. Klinik değerlendirme için VAS-ağrı skoru kullanıldı. Kondromalazi patella evrelemede Modifiye MRG Evreleme Sistemi kullanıldı. Vizüel analog skala (VAS)-ağrı

**Address for Correspondence:** İlknur Saral, Bahçeşehir University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Turkey

Phone: +90 532 318 05 52 E-mail: ilknurbsaral@gmail.com ORCID ID: orcid.org/0000-0001-7245-6304

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skoru ile izokinetik dinamometre parametreleri arasındaki ilişkinin yanı sıra radyolojik manyetik rezonans görüntüleme (MRG) evreleme, tedavi etkinliği ve semptom süresindeki korelasyon analiz edildi.  $P < 0,05$  değeri, istatistiksel anlamlı kabul edildi.

**Bulgular:** Etkilenen dizlerde fizik tedavi ve rehabilitasyon programı sonrası  $60^\circ$ /saniye ve  $180^\circ$ /saniye açısız hızlarda (PTE\_60, PTF\_60, PTE\_180, PTF\_180), diz fleksiyon ve ekstansiyon kas kuvvetlerinde istatistiksel olarak anlamlı iyileşme gözlemlendi ( $p=0,001$ ). Kondromalazi patella MRG evreleri, VAS-ağrı skoru, vücut kitle indeksi, semptom süresi ve tedavi etkinliği arasındaki korelasyon ve etkileşim analizi de istatistiksel olarak anlamlı bulundu ( $p < 0,05$ ).

**Sonuç:** Çalışma sonuçlarımız, fizik tedavi ve rehabilitasyon programının hem diz ekstansörlerinin hem de fleksörlerinin kuvvetini geliştirdiğini ve izokinetik parametrelerin tedavi etkinliği üzerinde önemli bir etkiye sahip olduğunu göstermektedir. İzokinetik dinamometre, kondromalazi patellalı hastaların tedavi etkinliğini değerlendirmek için, kesin bir izleme aracı olarak kullanılabilir. Daha ileri bilimsel kanıtlar için daha fazla çalışmaya ihtiyaç vardır.

**Anahtar Kelimeler:** Kondromalazi patella, kas kuvveti, dinamometre, izokinetik test, fizik tedavi ve rehabilitasyon

## INTRODUCTION

Chondromalacia patella is a commonly diagnosed disease at physical rehabilitation and arthrology clinics (1-7) and is a common cause of anterior knee pain among young individuals (8). This pain recurs after descending hills or stairs, knee-bend,  $90^\circ$  of knee flexion for an extended period of time (e.g. prolonged sitting), and repeated exercises of flexion/extension with extreme loading (1,2). Besides pain at knee cap area, and physical examination may reveal snapping or grinding sound during affected joint's movement (7). Histopathological examination ascertains hyaline cartilage damage overlying the patella (2).

Chondromalacia patella, also known as runner's knee, is a disease of sportive individuals such as runners, athletes, soccer players, bikers, skiers, gymnasts predominantly. Patellar trauma, patellofemoral instability, anatomic variations of bones, patellar kinematic abnormalities and occupation hazards are involved in the etiology. When there is extensive, and long-term bending, flexion, twist, constraint to the knee joint, overutilization and repetitive microtrauma occurs at the knee cap. As a result, intraarticular cartilage is degenerated, chondromalacia patella develops (1,3,7,8).

Noteworthy, the backbone of treatment for chondromalacia patella is physical therapy. Principal reasons for the use of physical therapy include decreasing patellofemoral pain, regaining of patellar alignment. It frequently involves exercises that focus on muscle strengthening (e.g. quadriceps, vastus medialis, hamstring); mobilization (e.g. patella); ice or heat packs for pain, soreness; therapeutic ultrasound; immobilizing cast; foot orthotics and/or devices that help walking. Besides this physical therapy, various modalities that does not involve the operation exists, ranging from immobilization to medicinal drugs. When aforementioned non-operative management fails, surgery can be an option (1,9,10).

Although magnetic resonance imaging (MRI) is the most frequently used non-invasive tool for diagnosis or differential diagnosis or monitorization the effects of therapy in patients

with chondromalacia patella (2-5), isokinetic dynamometer could be used for monitorization of knee disorders (11-13).

The study aimed to analyze the efficacy of isokinetic dynamometer as a monitoring tool for individuals with chondromalacia patella. In this study, isokinetic testing was used to monitor changes in knee muscle strength before and after physical therapy. The relationship between pain and isokinetic strength test was analyzed, as well as changes in radiological MR stages in patients with chondromalacia patella. Through the study, we also compared the changes of the muscle strength of the affected knee and the healthy knee before and after physical therapy.

## METHODS

Research subjects selected for this study were twenty-eight patients with chondromalacia patella, twenty males and eight females (mean age  $39 \pm 10.84$ ; age interval 21-62). Sixteen subjects presented chondromalacia patella for the left knee, and twelve subjects for the right knee. The reported mean duration of symptoms was  $11.75 \pm 7.38$  months. The study protocol was approved by Istanbul Medipol University Non-Invasive Clinical Research Ethics Committee (decision no: 1146, date: 25.11.2021), and written informed consent was obtained from each patient. The study was conducted in compliance with the principles of the Declaration of Helsinki.

Thirty-five consecutive patients who had clinical signs and symptoms of chondromalacia patella were referred to the radiology department for the diagnosis and MRI staging of chondromalacia patella. Modified MRI Staging System was used in the staging of chondromalacia patella. In this staging system, stage 0 is normal cartilage; stage 1 is softening or edema without contour irregularities in cartilage; stage 2 is fragmentation in cartilage, fissuring or focal defects below 50%; stage 3 is fragmentation, fissuring or defects above 50%; stage 4 is full-thickness cartilage lesions. Among these patients, a total of twenty-eight patients met the eligibility criteria were included in the study. The inclusion criteria were as follows: (i) aged 18-50 years; (ii) diagnosis of

chondromalacia patella according to modified MRI staging system. Exclusion criteria were as follows: (i) presence of neuromuscular and rheumatological disease; (ii) history of knee surgery; (iii) presence of severe hearing and vision impairment; (iv) presence of uncontrolled hypertension; and (v) pregnancy. Use of non-steroidal anti-inflammatory drug medications, incomplete follow up and inability to complete the isokinetic test is excluded from the study.

Demographic characteristics and past medical history of patients were obtained at the baseline assessment. A summary of age, height, weight, body mass index (BMI), duration of knee symptoms, the affected knee, chondromalacia patella stage by MRI, and gender is seen in Table 1.

In the study, isokinetic tests were performed with isokinetic dynamometer (HUMAC NORM, Version: 10.000.0039, CSMi, USA) to assess the bilateral knee flexor and extensor group muscles' strength (peak torque). Specifically, 60 PT\_E (Concentric Peak Torque for Extension); 60 PT\_F (Concentric Peak Torque for Flexion); 180 PT\_E and 180 PT\_F was recorded. None of the subjects had previously undergone isokinetic testing. Patients were seated upright and fixed with pelvic and distal thigh belts. They were allowed to hold on both sides of the chair with their hands. Muscle strength was measured concentrically at two angular velocities of 60°/s and 180°/s with five sets at each velocity. Subjects performed trial repetitions before each set and a 20 s resting interval was provided between the two sets. The muscle contraction variables measured were total extensor peak torque, total flexor peak torque, extensor peak torque difference and flexor peak torque difference (11-13).

All patients with chondromalacia patella had a physical therapy program including transcutaneous electrical nerve stimulation (TENS; 20 min, 60-120 Hz), cold pack therapy (15 min), therapeutic ultrasound (0.5 watt/cm<sup>2</sup>, 50% intermittent, 5 min), quadriceps muscle-strengthening exercises, stretching, and isokinetic exercise by the isokinetic dynamometer for 15 sessions, 5 days a week during 3 weeks.

Visual analog scale (VAS)-pain value, and isokinetic dynamometer scores before and after physical therapy were recorded for each patient at baseline and after 3 weeks.

### Statistical Analysis

The SPSS statistical package version 21.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. We applied the Kolmogorov-Smirnov assessment for testing normality of statistical distribution. Mean and standard deviation were used for continuous data. The association between categorical variables were determined using

Pearson's correlation coefficient, Paired samples t-test, and general linear model univariate analysis of covariance (GLM ANCOVA). A value of  $p < 0.05$  was considered significant.

## RESULTS

Twenty-eight patients with chondromalacia patella (20 males and 8 females, mean age  $39 \pm 10.84$  years (minimum: 21, maximum: 62 years), mean symptom duration  $11.75 \pm 7.38$  months, mean BMI  $24.67 \pm 3.18$  were included in the study. In our study population, all participants had unilateral chondromalacia patella [12 (42.86%) on the right side and 16 (57.14%) on the left side]. According to modified MRI staging system, 12 (42.9%) of the patients was stage 1, 9 of patients (32.1%) was stage 2, and 7 (25%) of patients was stage 3 (Table 1).

When we considered VAS-pain values, mean VAS-pain value was  $5.39 \pm 1.85$  at the beginning and  $2.11 \pm 1.16$  after 15 sessions. The VAS-pain values decreased after 15 sessions of physical therapy (-3.28 units) and this value was statistically significant ( $p < 0.0001$ , Table 2).

A statistically significant, very high positive correlation was found between the MRI staging and the duration of symptoms ( $r = 0.89$ ;  $p = 0.0001$ ). The duration of symptoms of patients with stage 1 was  $6.42 \pm 1.44$ , stage 2 was  $10.89 \pm 2.85$  and stage 3 was  $22.00 \pm 7.05$  months.

Pre-treatment and post-treatment of isokinetic test values in the affected knee and improvement compared to healthy knee are seen in Table 3.

**Table 1. Baseline characteristics of chondromalacia patella patients**

	Mean	Standard deviation	
Age (years)	39.00	10.84	
Height (cm)	175.04	11.03	
Weight (kg)	76.46	17.00	
Body mass index	24.67	3.18	
Duration of symptoms (months)	11.75	7.38	
	Number	Percentage (%)	
Affected knee	Right	12	42.9%
	Left	16	57.1%
Chondromalacia patella magnetic resonance stage	Stage 1	12	42.9%
	Stage 2	9	32.1%
	Stage 3	7	25.0%
Gender	Male	20	71.4%
	Female	8	28.6%

When we considered affected knees, post-treatment power torque 60-degree extensor (PTE\_60) and power torque 180-degree extensor (PTE\_180) mean values were statistically significantly improved compared to pre-treatment value (both p=0.0001 for the difference). Additionally, when we compared affected knees with the healthy knees, improvement was also statistically significant for PTE\_60 and PTE\_180 (p values were 0.008 and 0.006 respectively) (Table 3).

Besides, power torque 60-degree flexor (PTF\_60) and power torque 180-degree flexor (PTF\_180) difference between pre-treatment and post-treatment was also statistically significant in affected knees (both p=0.0001 for the difference). Nevertheless, PTF\_60 mean value of affected knees was statistically significantly improved compared to healthy knees (p=0.001; Table 3). However, when we considered PTF\_180 improvement compared to healthy knee, it was not statistically significant (p=0.170; Table 3).

We also analyzed correlation and interaction between chondromalacia patella MRI stages, VAS pain value, BMI, duration of symptoms, and treatment efficacy. It is shown in Table 3, column at the end of right side. We observed that isokinetic parameters of PTE\_60, PTF\_60, PTE\_180 has a significant effect on the treatment effectiveness (p values were 0.029; 0.018; and 0.017 respectively). Besides, a statistically significant relationship was found between VAS pain value and isokinetic parameters of PTE\_60, PTE\_180, and PTF\_60 (r=-0.41; p=0.03). If VAS pain value improved, treatment effectiveness was also improved.

**Table 2. VAS pain score of chondromalacia patella patients (pre-treatment and post-treatment)**

	Mean	Standard deviation
VAS pain pre-treatment	5.39	1.85
VAS pain post-treatment	2.11*	1.16

\*p<0.0001 versus VAS pain pre-treatment, VAS: Visual analog scale

## DISCUSSION

Chondromalacia patella is the most common lower limb problem encountered in clinical practice (14). According to the studies, a commonly used tool for assessing muscle strength of lower limb is isokinetic systems due to its inherent patient safety, objectivity, and reproducibility in testing measures (14,15).

As explained by Keating and Matyas (16), in previous studies, the influence of impairments on dynamometric measurements has been investigated by comparing measurements for an affected limb with that for a contralateral healthy limb. These studies have found that measurements for affected limbs to be lower than those for healthy limbs. The results of these investigations therefore support the notion that dynamometric measurements can reflect anticipated weakness in an injured limb (16). In our study, we used an isokinetic dynamometer as a monitoring tool for individuals with chondromalacia patella, and we compared affected limbs with contralateral healthy limbs.

**Table 3. Pre-treatment and post-treatment of isokinetic dynamometer values in affected knee and improvement compared to healthy knee**

Parameter	Treatment	Affected knee			Improvement compared to healthy knee			
		Mean ± SD	Difference	Correlation	Mean ± SD	Difference	Correlation	TE*MR*VAS*BMI*SS
60 power torque extensor	Pre-	94.86±51.82	<b>0.0001</b>	0.86	15.79±26.77	<b>0.008</b>	0.78	<b>0.020</b>
	Post-	127.64±57.86			6.68±19.53			
60 power torque flexor	Pre-	49.82±25.28	<b>0.0001</b>	0.78	23±20.67	<b>0.001</b>	0.42	<b>0.018</b>
	Post-	67.68±27.66			6.61±21.61			
180 power torque extensor	Pre-	61.93±30.48	<b>0.0001</b>	0.83	12.07±24.84	<b>0.006</b>	0.75	<b>0.017</b>
	Post-	87.57±36.29			2.68±18.27			
180 power torque flexor	Pre-	37.32±13.98	<b>0.0001</b>	0.65	12.14±16.5	0.170	0.12	0.636
	Post-	49.64±20.08			6.86±13.23			
TWDE	Pre-	1001.39±536.34	<b>0.0001</b>	0.83	11.5±27.06	0.086	0,51	0.092
	Post-	1460.07±602.58			3.61±16.84			
TWDF	Pre-	501.93±304.76	<b>0.001</b>	0.60	17.18±31.96	0.34	0.25	0.178
	Post-	751.11±419.55			10.54±26.9			

TE: Treatment efficacy, SS: Symptom duration, MR: Magnetic resonance, VAS: Visual analog scale, BMI: Body mass index, SD: Standard deviation, TWDE: Total work deficit extensor, TWDF: Total work deficit flexor

We think that our approach is consistent with the previous studies (16) because isokinetic muscle strength results of the affected knees were lower than healthy knees in our 28-patient study population.

In a case study, Lennington and Yanchuleff (17) examined the use of isokinetic system for treating chondromalacia patella. They used Cybex II (Cybex, Division of Lumex Inc., Ronkonkoma, NY) as a tool, and physical therapy. They found that the use of Cybex II isokinetic strengthening of quadriceps in short arch fashion appeared to be a reasonable treatment for chondromalacia patella (17). In concordance with this study, we found statistically significant improvement in chondromalacia patients with isokinetic strengthening and physical therapy.

In another study, Elton et al. (18), compared clinical examination findings (history, physical, and isokinetics) and arthroscopic findings in patients with chondromalacia patella (n=20). They found that physical examination including Cybex II isokinetic testing results was not statistically significant (18). In discordance with the study by Elton et al. (18), we found statistically significant correlation and interaction between chondromalacia patella MRI stages, VAS pain value, BMI, duration of symptoms, and treatment efficacy. We observed that isokinetic parameters of PTE\_60, PTF\_60, PTE\_180 has a significant effect on the treatment effectiveness (p values were 0.029; 0.018; and 0.017 respectively). Besides, a statistically significant relationship was found between VAS pain value and isokinetic parameters of PTE\_60, PTE\_180, and PTF\_60 ( $r=-0.41$ ;  $p=0.03$ ). If VAS pain value improved, treatment effectiveness was also improved.

In a recent study, Ozel et al. (19), evaluated the correlation between clinical and magnetic resonance findings of chondromalacia patella. They found that there was a positive correlation between age and MRI staging, and the highest coefficient obtained with patellar cartilage score (19). In our study, there are some similarities with this study because we found also a positive correlation with MRI staging and VAS-pain value, in addition to a positive correlation with MRI staging and duration of symptoms.

In a 2021 study, Ouazzani et al. (20), investigated isokinetic profile of knee extensor and flexor muscles in patellofemoral pain syndrome patients (n=58). They found that pain values were not correlated with isokinetic measurements (20). In discordance with this study, we found that there was a positive correlation between isokinetic measurements and VAS-pain value.

This study's small sample size limits the generalization of these outcomes to a larger population. A major limitation of

our study is the lack of the control group, we only compared affected knees with healthy knees in the same population. Also, the follow-up period of the study was 3 weeks and was not long enough. However, the strengths of our study were the isokinetic measurements of the patients before and after treatment, staging of all patients with MRI. Literature with isokinetic dynamometer in the treatment follow-up of patients with chondromalacia patella is relatively poor. In this respect, our study contributes to the literature.

## CONCLUSION

The results of this study showed that the isokinetic dynamometer may be a precise monitoring tool to assess treatment efficacy of patients with chondromalacia patella. More studies are needed for further scientific evidence.

## ETHICS

**Ethics Committee Approval:** The study protocol was approved by Istanbul Medipol University Non-Invasive Clinical Research Ethics Committee (decision no: 1146, date: 25.11.2021).

**Informed Consent:** Written informed consent was obtained from each patient.

## Authorship Contributions

Surgical and Medical Practices: E.T., E.Ç., Concept: H.B., Design: H.B., Data Collection or Processing: E.T., Analysis or Interpretation: M.A., Literature Search: H.B., Writing: İ.S.

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