Imaging Evaluation of Physical Activity Effect on Knee Articular Cartilage

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Conflict of Interest

The authors declare they do not have any conflict of interest.

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Introduction

✦Hyaline cartilage is a complex tissue with no vessels and little cellularity – limited healing capacity. (1,2)

✦ Injuries can progress to Osteoarthritis. (3)

✦ Tissue biomechanics are determined by interaction of collagen fibers, proteoglycans and interstitial fluid.

✦ Cartilage compression ➤ water flows out of matrix towards the joint space ➤ these mechanical interaction contributes to load absorbing function. (2,4)
Repeated joint loading can lead to reversible changes in cartilage thickness and volume. (5,6,7,8)

✦ Chondral thickness can also vary with age, body weight and exercise. (4)

✦ Excessive exercise can be harmful to cartilage. (6,8,9)

✦ With the advent of imaging exams, there has been progress in cartilage injuries diagnosis and treatment. (10,11,12)

✦ Studying physiological changes in response to exercises could help prevent progress to Osteoarthritis. (3,10,11,12,13)

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Objective

Analyze changes in knee cartilage thickness in healthy young volunteers before and after physical activity (1 hour of running).

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Material and Methods

The study was approved by the Ethic and Research Committee of the institution, linked to the National Research Ethics Commission (CAAE 46494721.7.0000.5696) All patients included in the study signed an informed consent form.

➤ Inclusion: 10 healthy young adult male volunteers, aged between 18 and 21 years old.

➤ Exclusion: Symptoms, history of trauma or previous surgeries in the knees.

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Material and Methods

➤ MRI of the right knee before and just after 1 hour of continuous running.

➤ Cartilage thickness was measure in the medial, lateral and patellofemoral compartments.

Statistical analysis: All variables were represented by mean and standard deviation. Differences between pre- and post-exercise means were analyzed using the Wilcoxon test. Significance level of 5% was adopted for all analyses. Data were analyzed using Stata/SE v.14.1 software (StataCorp LP, USA).

Material and Methods

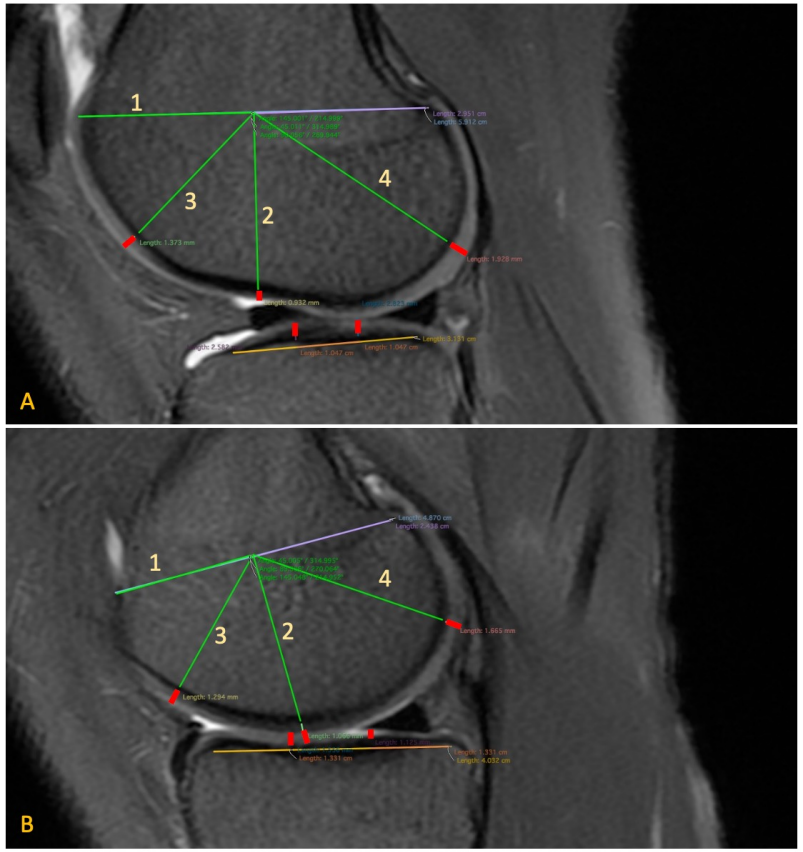

Figure 1. A: Lateral and B: Medial. Chondral thickness measuring points of the femoral condyle and tibial plateau – sagittal T2 view (small red lines).

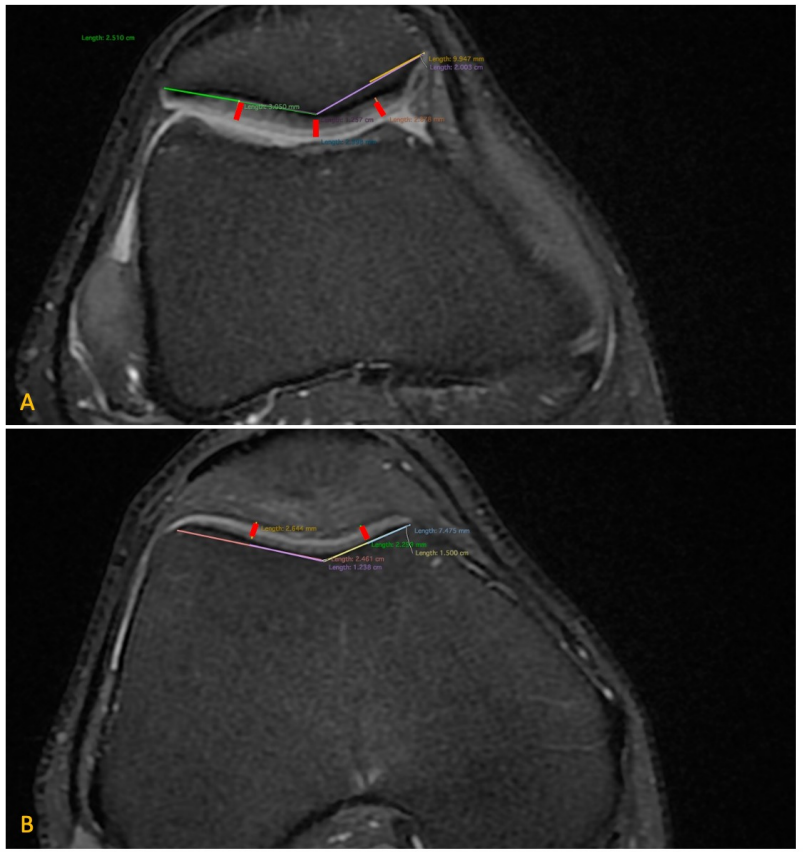

Figure 2: A: Measurement points of the patellar cartilage (small red lines). B: Trochlear measurement points (small red lines).

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Results

Table 1. Study volunteers demographic data

Variable	**Mean ± SD***
Age (years)	19.5 ± 0.52
Height (meters)	1.8 ± 0.09
Weight (kg)	75.2 ± 11.4
BMI**	23.14 ± 2.59

* Standard Deviation

**BMI: Body Mass Index

Table 2. Medial compartment evaluation pre- and post-running

	Condyle			Plateau	
	anterior	medial	posterior	anterior	posterior
Pre-running					
Mean	1.629	1.330	1.578	1.576	1.456
Standard Deviation	0.6	0.54	0.25	0.56	0.49
Post-running					
Mean	1.443	1.258	1.444	1.519	1.416
Standard Deviation	0.45	0.53	0.19	0.56	0.5
Variation	0.186	0.072	0.134	0.057	0.04
P value	0.009*	0.015*	0.002*	0.087	0.390

*Statistically significant
Values in millimeters (mm)

Table 3. Lateral compartment evaluation pre- and post-running

	Condyle			Plateau	
	anterior	medial	posterior	anterior	posterior
Pre-running					
Mean	1.925	1.08	2.009	2.682	2.957
Standard deviation	0.28	0.15	0.46	0.98	1.01
Post-running					
Mean	1.842	1.061	1.899	2.599	2.83
Standard deviation	0.27	0.16	0.52	0.95	0.95
Variation	0.083	0.019	0.11	0.083	0.127
P value	0.048*	0.554	0.296	0.005*	0.089

*Statistically significant
Values in millimeters (mm)

Table 4. Patello femoral compartment evaluation pre- and post-running

	Patella			Trochlea	
	medial	apex	lateral	medial	lateral
Pre-running					
Mean	4.005	3.682	4.149	2.849	2.783
Standard deviation	0.99	0.94	0.85	0.57	0.32
Post-running					
Mean	3.947	3.572	3.925	2.711	2.672
Standard deviation	0.93	0.92	0.85	0.59	0.26
Variation	0.108	0.11	0.224	0.138	0.111
P value	0.031*	0.009*	0.005*	0.002*	0.025*

*Statistically significant
Values in millimeters (mm)

Discussion

Boocock et al (17) evaluating the result of 30 minutes of running observed higher deformation in the lateral tibia (-5.7%), medial femur (-5.3%), lateral femur (-4%) and medial tibia (-3.3%).

Karanfil *et al.* (19) carried out a study very similar to ours with 22 male volunteers, but with only 30 minutes of running and showed more difference in the cartilage signal than thickness.

Mosher *et al.* (15) also evaluated the effect of 30-minute running in marathon athletes and compared it to a control group, and further divided each group into over 46 years old and under 45. The decrease in thickness was similar for athletes and non-athletes but was lower for the group over 46 years old. This shows that adult cartilage loses its load-absorbing capacity over time. (13)

Discussion

Although cartilage has ability to recover its volume and thickness after exercise, some studies suggest this may be limited depending on the intensity and duration of exercise.(6,13)

Systematic review and meta-analysis by Alentorn-Geli *et al.* (21) showed an overall hip and knee osteoarthritis prevalence of 3.66% in runners versus 10.23% in non-runners. Competitive runners showed a prevalence of 13.3%.
Another study also showed that elite long-distance runners have a 3 to 7 times higher prevalence of osteoarthritis compared to non-runners.(22)

Such findings suggest that recreational running can have a chondroprotective effect and competitive running can accelerate the degenerative process.

However, there is a failure to define a competitive or recreational runner in terms of km per week and race frequency. A suggested mean value of 21 to 42 km/week would **not** be associated to osteoarthritis.(21)

Limitations

The volunteers were young health individuals, and it was not possible to assess the effect of the same exercise on chondral tissue of older people or people with chondral injury.

The absence of a control group (no exercise).

There was also no other evaluation besides the one performed immediately after exercise, to show cartilage recovery time or if the observed changes will remain indefinitely.

Female subjects were not included as volunteers, which could be a bias as men have higher cartilage volume than women (14,24) and women's cartilage has a greater deformation response to exercise compared to men.(17)

Despite the limitations our study had clinical relevance as it demonstrated changes in knee cartilage thickness and these values can be used for comparison in the functional assessment of other group of individuals.

Conclusion

There was a decrease in knee chondral thickness after 60 minutes of running being statistically significant in the medial femoral condyle, anterior portion of the lateral femoral condyle and lateral plateau, and patellofemoral joint (patella and trochlea).

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