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A CONSIDERATION OF THE MYTH OF THE LUNAR EFFECT ON THE MYOCARDIAL INFARCTION: A RETROSPECTIVE COHORT STUDY

MİYOKARD ENFARKTÜSÜ ÜZERİNDEKİ AY ETKİSİ EFSANESİNİN DEĞERLENDİRİLMESİ: RETROSPEKTİF KOHORT ÇALIŞMASI

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Abstract

Introduction: In our medical center, we observed that myocardial infarction of proximal lesions occurs more frequently on some days and distal lesions occur more frequently on others. Along with this curiosity, our aim was to study whether the lunar cycle, location and distance from the Earth are related with the location of coronary occlusion, myocardial infarction type, and the shear force.

Materials and Methods: The movements of the lunar cycle day by day, hour by hour, and the Moon's distance from the Earth, were calculated. These parameters were then compared with myocardial infarction subtypes and culprit lesion location.

Results: Culprit lesion location (the distance from the coronary artery ostium and the vertical/horizontal direction according to Earth's gravity line) was not statistically significantly different according to the position of the Moon (p=0.32 and p=0.49). In the subgroup analysis, there was a statistically significant difference between the left anterior descending artery and the right coronary artery according to the Moon's hourly movement (p=0.02).

Conclusion: In conclusion, our analysis found that there is no association between culprit lesion location and the mechanical effects of the lunar cycle.

Keywords: Coronary occlusion, myocardial infarction, moon

Öz

Giriş: Merkezimizde, bazı günlerde proksimal lezyonlara bağlı bazı günlerde de distal lezyonlara bağlı myokard enfarktüsünün daha sık meydana geldiğini gözlemledik. Bu merakla birlikte, bu çalışmada ay döngüsünün, yerin ve Dünya'dan uzaklığın koroner oklüzyonun yeri, miyokard enfarktüsü tipi ve sürtünme kuvveti ile ilişkili olup olmadığının incelenmesi amaçlanmıştır.

Gereç ve Yöntemler: Ay döngüsünün hareketleri günden güne, saatten saate ve Ayın Dünya'dan uzaklığına göre hesaplandı. Bu parametreler daha sonra miyokard enfarktüsü alt tipleri ve sorumlu lezyon lokalizasyonu ile karşılaştırıldı.

Bulgular: Sorumlu lezyon yeri (koroner arter ostiumundan uzaklık ve Dünya'nın yerçekimi çizgisine göre dikey / yatay yön) Ayın konumuna göre istatistiksel olarak anlamlı derecede farklı değildi (p=0,32 ve p=0,49). Alt grup analizinde, Ayın saatlik hareketine göre sol anterior inen arter ile sağ koroner arter arasında istatistiksel olarak anlamlı bir fark vardı (p=0,02).

Sonuç: Sonuç olarak, analizimiz sorumlu lezyonun lokalizasyonu ile ay döngüsünün mekanik etkileri arasında bir ilişki olmadığını göstermiştir.

Anahtar Kelimeler: Ay, koroner oklüzyon, myokard enfarktüsü

Introduction

Acute myocardial infarction (AMI) is one of the most common mortal disease[1]. The total occlusion of coronary arteries causes ST elevation myocardial infarction (STEMI). Factors that cause the total occlusion of a coronary artery have always been a matter of curiosity for physicians. Therefore, many studies have been conducted on this area[2,3].

The lunar cycle has many effects on animal and human physiology[4]. Mostly, these have been attributed to hormonal changes and circadian rhythm[5]. Only a few studies have been conducted to show its mechanical effects[6]. Myocardial infarction (MI) and lunar cycle (LC) relevance has been observed in a some studies[7]. These studies were designed to discover whether the LC was associated with MI frequency. However, the association between myocardial infarction subtypes, coronary artery occlusion sites, and the LC have not been studied before.

In our medical center, we observed that on some days MI of proximal lesions occur more frequently and distal lesions occur more frequently on others. Along with this curiosity, our aim was to study whether the lunar cycle, location, and distance from the Earth are related with the coronary occlusion site, myocardial infarction type, and shear force.

Materials and Methods

- *Study Design and Patient Population*

This was a retrospective cohort single center study which used our center database. 554 STEMI or Non-STEMI patients with a least one totally occluded coronary artery were included in the study. The date and exact hour of the onset of ischemia related symptoms were obtained from hospital records. Patients' demographic information, chronic diseases, and drugs were recorded. Patients with missing information were excluded from the study. This retrospective study is in accordance with the June 1964 Declaration of Helsinki. The conduct of this study was approved by the Institutional Review Board at regional university (E-25403353-050.99-134591).

- *Coronary Angiography*

Coronary angiography (CAG) images were analyzed by two cardiology specialists. All patients were diagnosed with STEMI or at least one total coronary artery occlusion. For other coronary arteries, 70%, stenosis, or greater, denotes that the vessel is diseased. The number of stents and balloons applied to the culprit artery was also recorded. All culprit lesions were classified according to the BARI classification[8].

The coronary arteries were classified as proximal, mid, and distal for the calculation of the mechanical impact. In addition, the arteries were classified as horizontal or vertical according to the direction of the Earth's gravity (Table 1).

- *Lunar Cycle*

Lunar cycle was calculated according to 3 parameters. For all these parameters, our city was selected as the center of all events and the absolute time for the Moon's location was calculated according to the onset of ischemic symptoms. A popular internet site (www.mooncalc.org) was used to find the Moon's exact location at the event time. The first parameter is concerned with the movement of the Moon on its orbit. In this parameter, the effects of Moon's gravity on patients were compared with that of the Sun's. The Moon's movement on its orbit is completed in 28 days.

Table 1. Culprit lesion classification according to the distance to the coronary ostium and the Earth's gravity

Classification	According to the distance to the coronary ostium			According to the Earth's gravity	
	Proximal	Mid	Distal	Horizontal	Vertical
BARI Classification	1,12,18,28	2,13,15,16,19,20	3,4,5,9,14,19a,21,23	1,3,4,5,9,11,12,15,18,23,28	2,13,14,16,19,20,21

The position closest to the sun was tagged as day 14 and the farthest was as 0. Day by day, this movement has a value between 0 and 14 (Figure 1). The second parameter was the gravitational force of the moon on the patient according to distance between the Moon and our center. Normally, gravitational force is calculated with the formula $F = GxM1xM2/R^2$ (G: universal gravitation constant, M1: the Moon's mass, M2: the Earth's mass, and R: distance)[9]. In this formula, as only the distance is variable, we compared only the distance between the Moon and the Earth (Figure 2). The third parameter was the Moon's net gravitational force on patients accompanying with the Earth's. The Earth has a fixed gravitational force on our city, so, we decided to compare the Moon's gravity force hour by hour. The gravitational force of the Moon parallel to the direction of the Earth's gravity according to surface was calculated. If the Moon had risen, from the perspective of our center, its gravity was assumed as positive, and when the Moon had set and was behind the Earth, its gravity was assumed as negative. We assumed the Moon's gravitational force as 20000 units and we multiplied this force with the sinus of the angle between the Moon and the Earth. As a result, we found values between -19549 and 19390 (Figure 3).

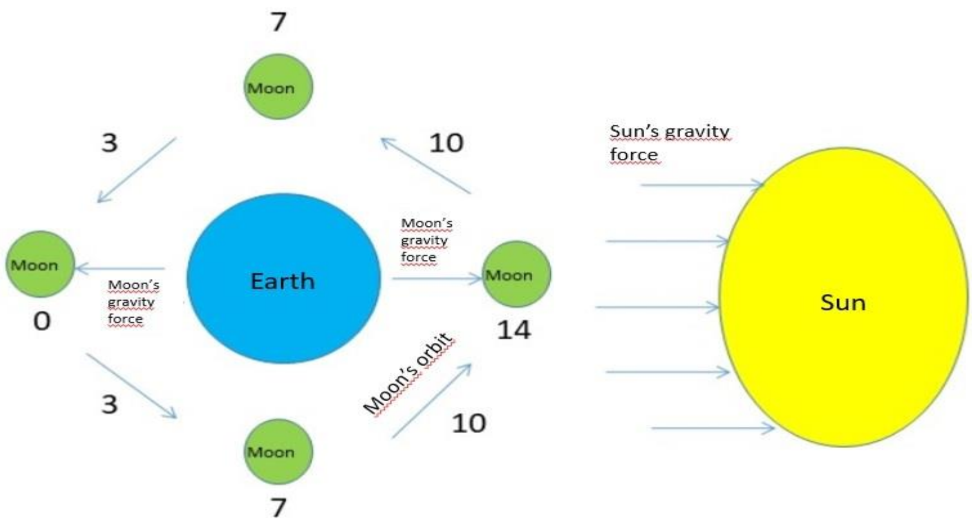

Figure 1. Figure 1 shows the Moon's movement on its orbit day by day and the Moon's net gravitational force on the Earth according to the Sun's gravity.

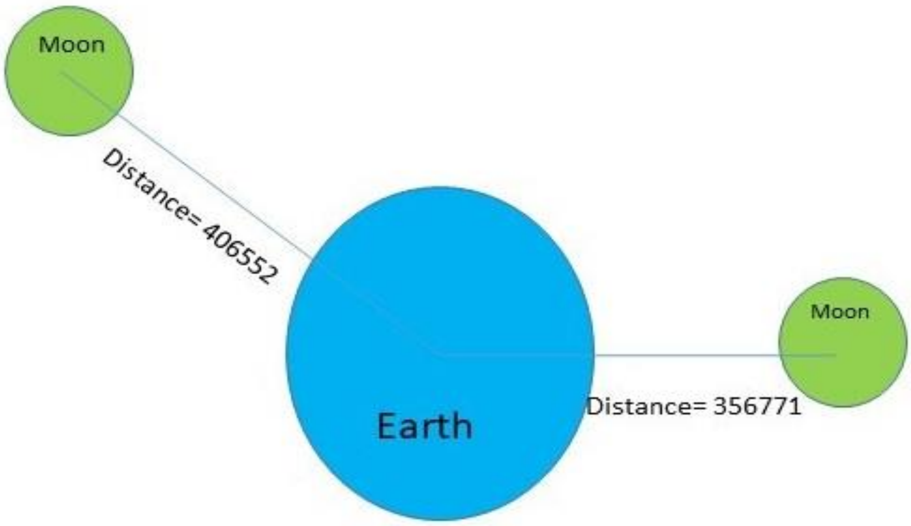

Figure 2. Figure 2 shows the Moon's distance from the center of the Earth.

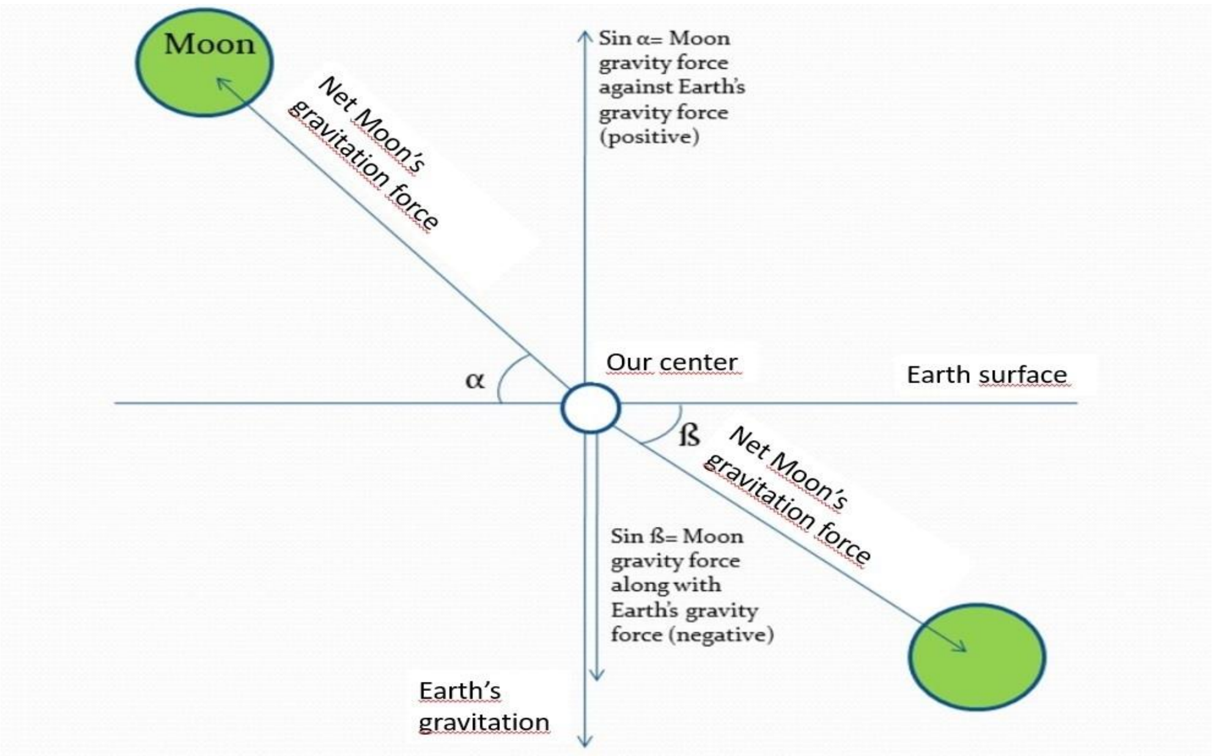

Figure 3. Figure 3 shows the Moon's net gravitational force on our city according to the Earth's gravity.

- *Statistical Analyses*

Categorical and continuous data were expressed as ratio (%) and median (range). Homogeneity of the groups were compared with Kolmogorov-Smirnov and Levene's test. These were compared by the chi-square, T-test, and One-way ANOVA tests, respectively. After finding a statistically significant difference according to One-way ANOVA, subgroup analyses were performed with the Tukey test to compare the subgroups. In addition, bivariate correlation analyses were performed to compare the Moon's movements and coronary lesion's locations. IBM SPSS Statistics for Windows v23 was used for statistical analyses. P values <0.05 were considered statistically significant.

Results

The baseline characteristics of all patients are shown in Table 2. The median age was 60 (29-62) years and male patients were more dominant (76.9%). Most of the patients came to our clinic with anterior and inferior MI. Furthermore, half of patients had only one diseased coronary artery that was the culprit vessel. (53.2%) (Table 2).
Culprit lesions were grouped as vertical or horizontal according to the direction of the Earth's gravity. These groups were compared with the Moon's orbital movement, daily movement, and distance from the Earth. All groups were homogeneous (Levene's test), and there were no statistically significant differences between groups (Table 3).
For another perspective, the culprit lesions were grouped as proximal, mid, and distal according to the distance from the ostium of the artery. Again, these groups were compared with the Moon's orbital movement, daily movement, and distance from the Earth. All groups were homogeneous and, again, there were no statistically significant differences between them (Table 4).
Finally, we compared the culprit vessel with Moon's orbital movement, daily movement, and distance from the Earth. All groups were homogeneous. The Moon's orbital movement and daily movement were statistically significantly different (Table 5). However, the Tukey test showed that there were statistically significant differences between the subgroups according to orbital movement. However, the Tukey test showed that left anterior descending (LAD) artery and right coronary artery (RCA) culprit lesions were statistically significantly different according to the Moon's daily movement (p=0.02) (Table 6).
Bivariate correlation analyses showed that there was no correlation between three type of the Moon's physical effects (distance, daily and hourly movement) and culprit lesions location (Table 7).

Discussion

In this present study, we found that the Moon's orbital movement, daily movement, and distance from the Earth are not associated with culprit lesion location. However, in our subgroup analysis, we found that the Moon's hourly movement is associated with LAD or RCA total occlusion.
In the literature, researchers have mostly studied the association between lunar phases and myocardial infarction frequency and there are conflicting results on this issue. Eisenburger et al., Wende et al and Kanth et al. found that lunar phases are not associated with MI frequencies[5,10,11]. In addition, Takagi et al. analyzed 7 studies and found similar results[12].

Table 2. The baseline and angiographic characteristics of patients (n=554)

Clinical Parameters	Number (%)	Angiographic Parameters	Number (%)
		Number of Stent Implants	
Gender (Male)	426 (76.9%)	0	80 (14.4%)
Smoker	288 (52%)	1	350 (63.2%)
Hypertension	385 (69.5%)	2	99 (17.9%)
Diabetes Mellitus	261 (47.1%)	3	18 (3.2%)
History of Coronary Artery Disease	94 (17%)	4	6 (1.1%)
		7	1 (0.2%)
Congestive Heart Failure	118 (21.3%)		
Atrial Fibrillation	19 (3.4%)	Number of Diseased Arteries	
Type of Myocardial Infarction		1	295 (53.2%)
Anterior MI	205 (37%)	2	175 (31.6%)
İnferior MI	245 (44.2%)	3	84 (15.2%)
Lateral MI	15 (2.7%)	Culprit Lesion According to the Earth’s Gravity	
Posterior MI	9 (1.6%)	Horizontal	288 (52%)
Non-STEMI	80 (14.4%)	Vertical	266 (48%)
		Culprit Lesion According to Ostial Distance	
		Proximal	214 (38.6%)
		Mid	267 (48.2%)
		Distal	73 (13.2%)

*MI: myocardial infarction, STEMI: ST elevation myocardial infarction

Table 3. Comparison of the Moon's distance, daily and hourly movement with culprit lesion location according to the direction of the Earth's gravity

Culprit Lesion Location According to the Direction of the Earth's Gravity	Vertical	Horizontal	*p*	LTEoV
Moon's Movement on its Orbit, Day by day (Daily tagged between 0-14)	7.11±4.14	6.82±3.98	0.41	0.32
Moon's Movement According to the Earth's Daily Movement, Hour by Hour (Unit)	-19.48 ±10823.25	39.61±11585.83	0.95	0.08
Distance (Kilometers)	384754.94±16120.27	385174.9±15524.47	0.75	0.24

- Parameters were given as mean ± standard deviation, LTEoV: Levene's Test Equality of Variance

Table 4. Comparison of the Moon's distance, daily and hourly movement with culprit lesion location according to coronary ostial distance

Culprit Lesion Location According to Coronary Ostial Distance	Proximal	Mid	Distal	*p*	LTEoV
Moon's Movement on its Orbit, Day by Day (Daily tagged between 0-14)	6.83±3.98	7.17±4.15	6.55±3.96	0.42	0.49
Moon's Movement According to the Earth's	774.04 ±11434.11	-32.36±10681.62	-2065.45±12321.66	0.17	0.08

Daily Movement, Hour by Hour (Unit)					
Distance (Kilometers)	385214.93±15667.13	384768.1±16104.22	385015.18±15259.4	0.95	0.34

- Parameters were given as mean ± standard deviation, LTEoV: Levene's Test Equality of Variance

Table 5. Comparison of the Moon's distance, daily and hourly movement with culprit coronary artery

Culprit Vessel	LAD	CX	RCA	*p*	LTEoV
Moon's Movement on its Orbit, Day by Day (Daily tagged between 0-14)	7.17±4.07	7.58±4.04	6.39±4.0	**0.027**	0.70
Moon's Movement According to the Earth's Daily Movement, Hour by Hour (Unit)	1470.21±11309.66	-506.78±10701.971	-1370.18±11228.1	**0.025**	0.42
Distance (Kilometers)	384965.56±15628.62	384670.83±16377.26	385141.93±15758.867	0.969	0.59

- Parameters were given as mean ± standard deviation
- LTEoV: Levene's Test Equality of Variance

Table 6. Subgroup analyses of the comparison of the Moon's daily and hourly movement with culprit coronary artery

Dependent Variable				Mean Difference (I-J)	Std. Error	*p*	95% Confidence Interval Lower Bound	Upper Bound
Moon's Movement on Its Orbit Day by Day (Daily tagged between 0-14)	Tukey HSD	LAD	CX	-0.303	0.474	0.799	-1.42	0.81
			RCA	0.812	0.382	0.086	-0.09	1.71
		CX	LAD	0.303	0.474	0.799	-0.81	1.42
			RCA	1.115	0.486	0.057	-0.03	2.26
		RCA	LAD	-0.812	0.382	0.086	-1.71	0.09
			CX	-1.115	0.486	0.057	-2.26	0.03
Moon's Movement According to Earth's Daily Movement Hours by Hours (Unite)	Tukey HSD	LAD	CX	2069.876	1308.475	0.254	-1005.12	5144.87
			RCA	2834.030	1055.160	**0.020**	354.34	5313.72
		CX	LAD	-2069.876	1308.475	0.254	-5144.87	1005.12
			RCA	764.154	1340.234	0.836	-2385.48	3913.79
		RCA	LAD	-2834.030	1055.160	**0.020**	-5313.72	-354.34
			CX	-764.154	1340.234	0.836	-3913.79	2385.48

LAD: Left anterior descendent artery, CX: Circumflex artery, RCA: Right coronary artery

Table 7. Correlation analyses of the Moon's movements and culprit lesion's locations

Correlation Analyses		Proximal-Distal	Vertical-Horizontal
Hourly Movement	Correlation	-0.75	0.003
	p	0.076	0.951
	Number	554	554
Distance	Correlation	-0.008	0.013
	p	0.846	0.755
	Number	554	554
Daily Movement	Correlation	-0.002	-0.002
	p	0.965	0.965
	Number	554	554

Furthermore, Segan et al. conducted a study to research the association between STEMI outcomes and lunar phases[13] and found no relevance between these parameters. However, in another study, researchers found that MI frequencies were comparable with lunar phases[7].In our study we wanted to investigate not only MI frequency, but also the culprit vessel type and culprit lesion location. In the light of the conflicting results mentioned, we established our study with a different approach. We compared the Moon's daily gravitational force against Sun's. If Sun and Moon were on the same side of the Earth, we assumed that they had an additive effect, and we tagged this situation with the number 14. In contrast, if Sun and Moon were on opposite sides, we assumed that they had a negative effect on each other, and we tagged this situation with number 0. The Moon's daily orbital movement was also tagged between 0 and 14 (the Moon's orbital movement is completed in 28 days). We found no statistically difference for culprit vessel type and culprit lesion location with this calculation.

Most of the studies explained lunar effects on myocardial infarction with non-mechanical effects. In one study, researchers found that the difference in the Moon's gravitational force affects MI frequencies[6]. From the perspective of our study, this difference might also be associated with mechanical effects. With this in mind, we considered that the shear stress difference on coronary lesions according to gravitational force variation was worth investigating. However, there were no statistically significant differences for culprit vessel type and culprit lesion location according to the Moon's distance that influences its gravitational force on the Earth.

Different from previous studies, we thought that the Moon's location at the time of the onset of symptoms may influence coronary artery total occlusion. Especially, that shear stress in line with the Earth's gravity (vertical) may affect the location of total occlusion. If the Moon had risen, from the perspective of our center, we assumed that the Moon decreased the Earth's gravity force on patients. and, if Moon had set and was behind the Earth, it had additive effect on the Earth's gravitational force for patents (Figure 3). We found that, neither culprit lesion in the vertical side of the coronary artery nor the distance from the coronary ostium (proximal/mid/distal) were statistically significantly different. However, we found that if the Moon had risen and was above our city, LAD occlusion was statistically higher compared with RCA occlusion, and vice versa if the Moon was behind the Earth. In our opinion, RCA feeds mostly the inferior side of the heart and the Moon's additive force with Earth's gravity creates much more shear stress on this coronary artery but, this comment should be investigated further in the subsequent studies.

There are some limitations that should be mentioned. Firstly, this is a retrospective study. In the future, cross-sectional or prospective studies on this issue are needed. Secondly, this study was completed at only one center and had a limited patient number. In subsequent studies, more patients will increase the statistical significance. Thirdly, in this study, we only considered culprit lesion locations, however, long term outcome results associated with lunar effects will be more valuable. Finally, we assumed the patient's symptom onset time as the coronary event onset time. However, this is subjective data that may be influenced by the patient's pain feeling perspective, as such, in further studies, more objective data may be selected.

Conclusion

In conclusion, we found no relationship between lunar effects and culprit lesion locations in myocardial infarction. As a result, the myth of the lunar effects on myocardial infarction seems irrational and should be reconsidered.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical approval

Institutional Review Board at regional university (E-25403353-050.99-134591)

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