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Evaluation of the Relationship Between Carpal Bone Morphology and Distal Radius Fracture Pattern

Karpal Kemik Morfolojisi ile Distal Radius Kırık Paterni Arasındaki İlişkinin Değerlendirilmesi

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Abstract

Aim: In this study, we examined whether carpal bones (lunate, hamate, capitate) morphologies and fourth metecarp-capitate articulation have an effect on the distal radius fracture pattern.

Material and Method: 206 patients who applied to the emergency department with distal radius fracture between 2016-2020 were included in the study. Preoperative and pre-reduction x-ray films of the patients were examined. Lunate, hamate, capitate morphologies and 4.metacarp articulation analyzed and classified. Distal radius fracture types were classified according to AO and Fernandez. The relationship between carpal bone morphology and distal radius fracture type was analyzed.

Results: This study consisted of 101 men and 103 women. AO fracture types and carpal bone morphologies (lunate joint type according to Viegas, lunate type according to Zapico, capitate morphology, hamate morphology and capitate-4 metacarpal joint morphology) did not differ significantly ($p > 0.05$). Fernandez fracture types and carpal bone morphologies (lunate joint type according to Viegas, lunate type according to Zapico, capitate morphology, hamatum morphology and capitate-4.metacarp joint morphology) were compared, there was no significant difference ($p > 0.05$).

Conclusion: As a result, no clear relationship could be demonstrated between carpal bone morphology and distal radius fracture pattern.

Keywords: Carpal morhology - distal radius fracture - fracture type

Öz

Amaç: Bu çalışmada, karpal kemiklerin (lunate, hamate, kapitat) morfolojilerinin ve dördüncü metekarp-kapitat artikülasyonunun distal radius kırık paterni üzerinde bir etkisi olup olmadığını inceledik.

Gereç ve Yöntem: 2016-2020 yılları arasında acil servise distal radius kırığı ile başvuran 206 hasta çalışmaya dahil edildi. Hastaların ameliyat öncesi ve redüksiyon öncesi röntgen filmleri incelendi. Lunat, hamate, kapitat morfolojileri ve 4.metacarp artikülasyonu analiz edilerek sınıflandırıldı. Distal radius kırık tipleri AO ve Fernandez'e göre sınıflandırıldı. Karpal kemik morfolojisi ile distal radius kırığı tipi arasındaki ilişki analiz edildi.

Bulgular: Bu çalışmaya 101 erkek ve 103 kadın dahil edildi. AO kırık tipleri ve karpal kemik morfolojileri (Viegas'a göre lunat eklem tipi, Zapico'ya göre lunat tipi, kapitat morfolojisi, hamat morfolojisi ve kapitat-4 metakarpal eklem morfolojisi) anlamlı farklılık göstermedi ($p > 0.05$). Fernandez kırık tipleri ve karpal kemik morfolojileri (Viegas'a göre lunat eklem tipi, Zapico'ya göre lunat tip, kişi morfolojisi, hamatum morfolojisi ve kapitat-4.metacarp eklem morfolojisi) karşılaştırıldığında, anlamlı bir fark yoktu ($p > 0.05$).

Sonuç: Sonuç olarak, karpal kemik morfolojisi ile distal radius kırık paterni arasında net bir ilişki gösterilememiştir.

Anahtar Kelimeler: Karpal morfoloji - distal radius kırığı - kırık tipi

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INTRODUCTION

Distal radius fractures are one of the most common orthopedic injuries. The frequent occurrence of this injury has led to many clinical studies. In addition, there have been many studies recently showing the effect of carpal bone morphology on wrist pathologies. New information about carpal bone morphology has provided a lot of information that allows us to understand wrist orthopedic problems and injury patterns. However, there are not enough publications showing the effect of the morphology of the carpal bones on the distal radius fracture type.

The wrist is a complex structure formed by carpal bones, metacarpals, ulna, radius and ligaments between them. The shape of the carpal bones and the joints they form show different morphological features. Two different lunate morphologies have been described in the literature.[1] Type 1 lunate does not articulate with the hamatum. Type 2 lunate has a medial facet and articulates with the hamatum. Apart from this, there is Antuno-Zapico (A-Z) classification.[2] In A-Z type 1, the angle between the proximal part of the lunate and the articular part of the scaphoid is greater than 130 degrees. In A-Z Type 2, this angle is below 130 degrees. A-Z type 3, on the other hand, has two different facets that articulate with the radius and TFCC.

The capitate bone is morphologically divided into 3 types according to the proximal articular surface.[3] Type 1 has a flat surface, type 2 has a spherical surface and type 3 has a V surface. These morphological types were also shown on X-ray film.[4] In addition, the 4th metacarpal and the joint it forms show significant variations.[5] While the 4th metacarpal always articulates with the hamatum, it does not always articulate with the capitate. The type of this joint is easily detected on X-ray. The hamate bone is morphologically divided into two types according to the presence of a groove on it.[6] If there is no groove on it, it is called type 1, and if there is a groove on it, it is called type 2.

Many studies have been conducted on the effect of the morphology of the carpal bones, especially the lunate, on wrist pathologies.[7-10] There are also studies on the distal radius fracture mechanism.[11-13] However, the relationship between carpal bone morphology and distal radius fracture pattern has not been clearly demonstrated in the literature. In this study, we examined whether carpal bone morphology has an effect on the distal radius fracture pattern.

MATERIAL AND METHOD

The study was carried out with the permission of Sancaktepe Prof. Dr. İlhan Varank Training and Research Hospital Scientific Researches Ethics Committee (Date: 27/10/2021, Decision No: 2021/203), 206 patients who applied to the emergency department with distal radius fracture between 2016-2020 were included in the study. Demographic and medical information of the patients were analyzed from hospital records.

Preoperative and pre-reduction x-ray films of the patients were examined. The distal articular morphology of the lunate (**Figure 1**) was classified as type 1 and type 2 according to Viegas. In addition, 3 different morphological types of lunate were recorded according to A-Z classification. Hamatum (**Figure 2**) was analyzed and classified according to the presence of grooves. The capitatum was divided into morphological types according to their head shapes (**Figure 3**). If there was a horizontal lunate joint, it was classified as flat. It was classified as V-type if there were different articular surfaces for the lunate and scaphoid, and as spheric, if the lunate and scaphoid articular surfaces were convex. It was recorded whether it formed a joint with the 4th metacarpal (**Figure 4**) with the capitate. Distal radius fracture types were classified according to AO and Fernandez.

Figure 1. Lunate type 1 (Viegas)

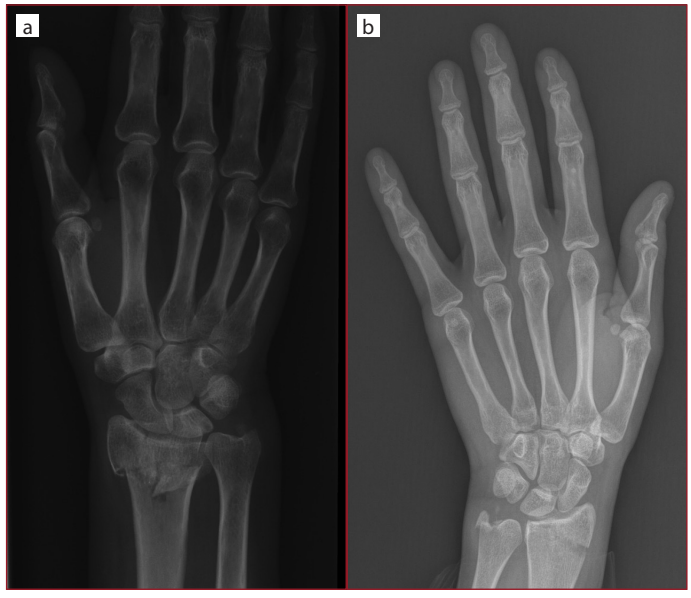

Figure 2. a) Hamate type 1, **b)** Hamate type 2

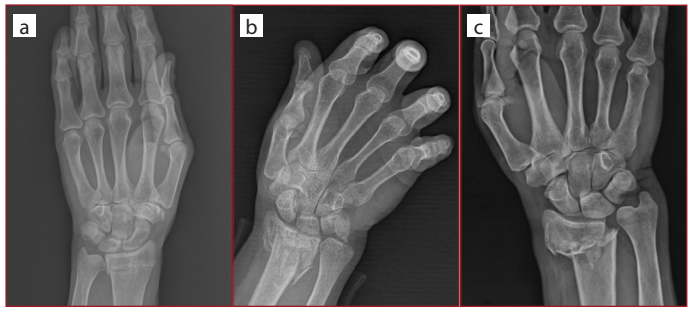

Figure 3. a) Spheric type capitate, **b)** Flat type capitate, **c)** V-type capitate

Figure 4. Capitate and 4.metacarp articulation

In the statistical method, mean, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured with the Kolmogorov-Smirnov test. ANOVA (Tukey test) was used in the analysis of quantitative independent data. The Chi-square test was used in the analysis of qualitative independent data. SPSS 27.0 program was used in the analysis.

RESULTS

This study consisted of 101 men and 103 women. The mean age of the patients was 48 years (range 19-79) and 98 of them were right side and 106 were left side. 57 patients were treated surgically with volar plate and 147 patients were treated with closed reduction and plaster cast.According to Viegas lunate joint type, 64 (31.4%) patients were classified as type 1 and 140 (68.6%) patients were classified as type 2. According to A-Z lunate morphology, 50 (24.5%) patients were classified as A-Z type 1.5, 56 (27.5%) patients as A-Z type 2, 98 (48.0%) patients as A-Z type 3. When the morphology of the hamatum was examined, it was determined as type 1 in 58 (28.4%) patients and type 2 in 146 (71.6%) patients. When the capitatum morphology was examined, 76 (37.3%) patients were flat type, 114 (55.9%) patients were spherical, 14 (6.9%) patients were V-shaped. Considering the relationship between the Capitate and the 4th metacarpal joint, it was found that 63 (30.9%) patients did not form a joint, while it was found to form a joint in 141 (69.1%) patients. When distal radius fracture types were analyzed according to AO, 122 (59.8%) patients were found to be type A, 14 (6.9%) patients as type B, and 68 (33.4%) patients as type C. When examined according to the Fernandez classification, 122 (59.8%) patients were classified as type 1, 10 (4.9%) patients as type 2, 55 (27.0%) patients as type 3 and 17 (8.4%) patients as type 5. (**Table 1**)

Table-1. Demographic information of the patients

		Min-Max	Median	Med.±s.d. /n-%	
Age		19,0 79,0	50,0	48,7 ± 13,7	
Gender	Male			101	49,5%
	Female			103	50,5%
Side	Right			98	48,0%
	Left			106	52,0%
Lunate Joint Type (Viegas)	I			64	31,4%
	II			140	68,6%
Lunate A-Z Classification	A-Z I			50	24,5%
	A-Z II			56	27,5%
	A-Z III			98	48,0%
Hamate Type	I			58	28,4%
	II			146	71,6%
Capitate and 4. Metacarp Articulation	Avaible			63	30,9%
	Unavaible			141	69,1%
Capitate Morphology	Flat			76	37,3%
	Spherical			114	55,9%
	V-Shaped			14	6,9%
AO Classification	A			122	59,8%
	B			14	6,9%
	C			68	33,3%
Fernandez Classification	I			122	59,8%
	II			10	4,9%
	III			55	27,0%
	IV			0	0,0%
	V			17	8,3%
Treatment	Plate			57	27,9%
	Closed reduction and Cast			147	72,1%

In the group with AO fracture type A, the age of the patients and the female ratio were significantly higher ($p < 0.05$) than the group with AO fracture type B-C. AO fracture types and carpal bone morphologies (lunate joint type according to Viegas, lunate type according to Zapico, capitate morphology, hamate morphology and capitate-4 metacarpal joint morphology) did not differ significantly ($p > 0.05$).(**Table 2**) The age and female ratio of patients in the group with Fernandez fracture type I were significantly ($p < 0.05$) higher than the group with Fernandez fracture type II-III-V. When Fernandez fracture types and carpal bone morphologies (lunate joint type according to Viegas, lunate type according to Zapico, capitate morphology, hamatum morphology and capitate-4.metacarp joint morphology) were compared, there was no significant difference ($p > 0.05$). (**Table 3**)

Table-2: Comparison of AO classification and carpal morphology

		AO Type-A		AO Type-B		AO Type-C		p
		Med.±s.d. /n-%		Med..±s.d. /n-%		Med.±s.d. /n-%		
Age		51,3±13,9		40,4±13,4		45,7±12,3		0,002[AA]
Gender	Male	47	38,5%	8	57,1%	46	67,6%	0,001[X²X²]
	Female	75	61,5%	6	42,9%	22	32,4%	
Fracture Side	Right	60	49,2%	6	42,9%	32	47,1%	0,887[X²X²]
	Left	62	50,8%	8	57,1%	36	52,9%	
Lunate Joint Type (Viegas)	I	44	36,1%	5	35,7%	15	22,1%	0,128[X²X²]
	II	78	63,9%	9	64,3%	53	77,9%	
Lunate A-Z Classification	A-Z I	30	24,6%	2	14,3%	18	26,5%	0,909[X²X²]
	A-Z II	34	27,9%	4	28,6%	18	26,5%	
	A-Z III	58	47,5%	8	57,1%	32	47,1%	
Hamate Type	I	37	30,3%	5	35,7%	16	23,5%	0,501[X²X²]
	II	85	69,7%	9	64,3%	52	76,5%	
Capitate and 4. Metacarp Articulation	Avaible	40	32,8%	3	21,4%	20	29,4%	0,650[X²X²]
	Ubavaible	82	67,2%	11	78,6%	48	70,6%	
Capitate Morphology	Flat	43	35,2%	8	57,1%	25	36,8%	0,484[X²]
	Spherical	69	56,6%	6	42,9%	39	57,4%	
	V-Shaped	10	8,2%	0	0,0%	4	5,9%	
Treatment	Plate	13	10,7%	7	50,0%	37	54,4%	0,000[X²]
	Closed Reduction	109	89,3%	7	50,0%	31	45,6%	

A ANOVA / X^2 Ki-square test

Table 3: Comparison of Fernandez classification and carpal morphology

		Fernandez Fracture Type-I		Fernandez Fracture Type-II		Fernandez Fracture Type-III		Fernandez Fracture Type-V		p
		Med.±s.d. /n-%		Med.±s.d. /n-%		Med.±s.d. /n-%		Med.±s.d. /n-%		
Age		51,3 ±13,9		39,5 ±13,4		46,3 ±12,2		43,1 ±13,2		0,003[AA]
Gender	Male	47	38,5%	6	60,0%	33	60,0%	15	88,2%	0,000[X²X²]
	Female	75	61,5%	4	40,0%	22	40,0%	2	11,8%	
Fracture Side	Right	60	49,2%	4	40,0%	24	43,6%	10	58,8%	0,673[X²X²]
	Left	62	50,8%	6	60,0%	31	56,4%	7	41,2%	
Lunate Joint Type (Viegas)	I	44	36,1%	3	30,0%	13	23,6%	4	23,5%	0,352[X²X²]
	II	78	63,9%	7	70,0%	42	76,4%	13	76,5%	
Lunate A-Z Classification	A-Z I	30	24,6%	1	10,0%	16	29,1%	3	17,6%	0,668[X²X²]
	A-Z II	34	27,9%	3	30,0%	16	29,1%	3	17,6%	
	A-Z III	58	47,5%	6	60,0%	23	41,8%	11	64,7%	
Hamate Type	I	37	30,3%	3	30,0%	13	23,6%	5	29,4%	0,836[X²X²]
	II	85	69,7%	7	70,0%	42	76,4%	12	70,6%	
Capitate and 4. Metacarp Articulation	Avaible	40	32,8%	2	20,0%	14	25,5%	7	41,2%	0,500[X²X²]
	Unavaible	82	67,2%	8	80,0%	41	74,5%	10	58,8%	
Capitate Morphology	Flat	43	35,2%	5	50,0%	22	40,0%	6	35,3%	p>0.05[X²]
	Spherical	69	56,6%	5	50,0%	32	58,2%	8	47,1%	
	V-Shaped	10	8,2%	0	0,0%	1	1,8%	3	17,6%	
Treatment	Plate	13	10,7%	4	40,0%	27	49,1%	13	76,5%	0,000[X²]
	Closed reduction	109	89,3%	6	60,0%	28	50,9%	4	23,5%	

A ANOVA / X^2 Ki-square test

DISCUSSION

This retrospective study evaluates the distal radius fracture pattern and carpal bone morphology. Radiographic analysis was performed in a relatively large group of patients. Distal radius fracture patterns were classified according to AO and Fernandez, which are frequently used in clinical practice. Lunate, hamatum, capitate, 4th metacarp-capitate joint was divided into morphological types. It was investigated whether these sub-morphologies have an effect on fracture types according to AO and Fernandeze.

There are many studies in the literature on lunate morphology and wrist pathologies. Especially in Kienböck's disease, lunate morphology has been frequently investigated.[14-16] In addition, the relationship between lunate morphology and scaphoid fracture was investigated, and it was shown that scaphoid fractures were more common in patients with Type 2 lunate compared to Viegas.[17] In addition, the effect of lunate morphology on carpal collapse in scaphoid nonunion and scapholunate dissociation has been shown.[7,8] In our study, we saw that the lunate morphology did not change the type of fracture in the distal radius compared to AO and Fernandez. Subtypes related to hamate morphology have been shown in the literature.[6,18,19] However, no study has been conducted on the effect of hamate morphology on wrist traumatic situations. In our study, we observed that the morphological types of the hamate bone had no effect on the distal radius fracture pattern. Like other carpal bones, studies on capitate bone morphology have been carried out and sub-morphological types have been determined.[3,4] The effect of these sub-morphological types on wrist pathologies has been investigated in the literature,[20] and it has been shown that the V-type capitate exerts more pressure on the distal radius in various wrist positions in patients who have undergone proximal row carpectomy. In our study, we observed that the morphological types of the capitate bones did not affect the distal radius fracture pattern. Distal radius fractures are caused by falling on the open hand and axial load transfer.[21] Some of this axial load transfer takes place over the metacarpals. In our study, we found that whether the capitate forms a joint with the 4th metacarp has no effect on fracture types.

Distal radius fracture is the most common fracture after hip fracture in the elderly population and is more common in women than in men.[22] It usually occurs with low-energy trauma in the elderly. Low bone mineral density is a risk factor especially for the elderly female population.[23] In our study, we observed that the elderly generally have extra-articular fractures (AO type A). This may be due to low-energy trauma in the elderly. In addition, in our study, we observed that extra-articular fractures were more common in the elderly female population than in the elderly male population. The reason for this can be shown as an earlier decrease in bone mineral density due to menopause in women.

CONCLUSION

As a result, no clear relationship could be demonstrated between carpal bone morphology and distal radius fracture pattern. Extra-articular fractures are more common in elderly female patients. Low-energy traumas are more common in this group of patients. When the fracture pattern is evaluated, the effect of the age and gender of the patients is more evident than the morphological features of the wrist.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Sancaktepe Prof. Dr. İlhan Varank Training and Research Hospital Scientific Researches Ethics Committee (Date: 27/10/2021, Decision No: 2021/203).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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