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Etiological and epidemiological analysis of patella fractures: evaluation of COVID-19 pandemic and lockdown era effects

Nezih Ziroğlu[1], Alican Koluman[2], Miraçhan Kantarcı[2], Altuğ Duramaz[2], Cemal Kural[2]
[1]*Department of Orthopedics and Traumatology, Acıbadem University, Acıbadem Atakent Hospital, İstanbul, Turkiye*
[2]*Department of Orthopedics and Traumatology, Bakırköy Dr. Sadi Konuk Training and Research Hospital, İstanbul, Turkiye*

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ABSTRACT

Aims: Patella fractures are relatively rare, but significant public health burden with consequences ranging from skin problems to extensor mechanism deficiencies and patellofemoral arthrosis due to their significant effects on pain, functionality, and quality of life. It was aimed to present basic etiological, and epidemiological information about patella fractures and to evaluate the impact of the COVID-19 Pandemic and lockdown era period.

Methods: All patellar fractures admitted to a level-1 trauma center between 2016 and 2022 were collected retrospectively. Patient's gender, age, side, fracture classification, trauma mechanism, treatment method, admission day and season, accompanying extremity, and non-musculoskeletal/visceral pathologies were recorded and analyzed.

Results: A retrospective evaluation was conducted on 304 patients, with 181 (59.5%) males and 123 (40.5%) females, with an average age of 46±19 years. Most patients were between 30-65 (51.4%) and the most common cause was simple falls (74%). Fractures mostly occurred in the winter (35.2%) and on Sundays (19.7%). 9.9% of the patients were accompanied by extremity traumas and 6.9% by non-musculoskeletal injuries. Regarding the descriptive classification, transverse, distal pole, and proximal pole; and according to the AO/OTA classification, C1 was the most common. Although an increase in the number of cases was observed over the years, this changed during the pandemic period and an upward trend restarted after the pandemic. Although surgical treatment rates, like the number of cases, decreased during the pandemic period, they still catch up with and exceed pre-pandemic periods over the years.

Conclusion: The incidence of patella fractures is increasing. Non-surgical treatment is a priority, and the complication rates of surgical treatment are considerable. The study, which presents etiological and epidemiological data of level-1 trauma center patients, is a suitable sample for Turkiye. The study is unique in showing the potential effects of COVID-19 on the patient profile and treatment management of patella fractures.

Keywords: Kneecap, sesamoid bone, knee, genu, incidence, characteristic

INTRODUCTION

The patella is the largest sesamoid bone of the body.[1] The posterior joint surface articulates with the femoral trochlea and forms the patellofemoral (PF) joint.[2] It plays a key role in the knee extensor mechanism by being located between the quadriceps proximally and the patellar tendon distally.[3] Fractures are relatively rare, accounting for 0.7%-1% of all fractures.[4-6]

Trauma and fractures can create a public health burden by causing PF joint and extensor mechanism pathologies, leading to pain, quality of life, and functionality problems.[7,8] Treatment of patella fractures often depends on the fracture pattern. While conservative treatment is generally preferred for non-displaced fractures that do not disrupt the extensor mechanism, intra-articular and displaced fractures where the extensor mechanism is disrupted are generally treated surgically.[5,9] Surgical treatment of patella fractures is linked to a significant risk of complications.[10] An increase in the need for total knee prosthesis has been shown in inappropriately and inadequately treated patellar fractures.[8]

There are limited studies regarding the type and incidence of patella fractures, accompanying fractures and pathologies, mechanism of injury, treatment applied, and complications encountered.

It was aimed to describe the characteristics and socio-demographic data of patella fractures, which can be observed in all age groups and cause various complications if not treated appropriately, to provide updated information on the incidence of fractures, and to detail the injury mechanisms, treatment methods, and possible complications. It was aimed to report the effects of the COVID-19 pandemic and the lockdown era.

Corresponding Author: Nezih Ziroğlu, nezih.ziroglu@yahoo.com

METHODS

Patients with radiologically confirmed patellar fractures who were admitted to our hospital, a level-1 trauma center, between January 2016 and December 2022, were included in the study. Following Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethics Committee approval (Date: 05.08.2024, Decision No: 2024-07-), data were collected retrospectively from the hospital data storage system. Fracture classification, age, gender, trauma mechanism, date, day, and season of trauma, side, accompanying additional extremity trauma, treatment applied, accompanying head, thorax, and abdomen pathologies, and complications were recorded. A total of 304 patients diagnosed with patella fractures were studied. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Data Collection

Trauma mechanism was divided into two main groups: Low and high-energy injuries. High-energy injuries were examined in three groups: traffic accidents, falls from height, and gunshot injuries. Low-energy injuries included simple traumas such as indoor falls, falls from the same level, and sports injuries. Accompanying orthopedic injuries and other system injuries were also classified.

Patella fractures were classified into seven subgroups according to Arbeitsgemeinschaft für osteosynthesefragen (AO) classification and fracture pattern (nondisplaced simple, transverse, apex or lower end, vertical, osteochondral, fragmented nonseparated, fragmented displaced). Treatment was divided into conservative/non-operative and surgical/operative, and complications were recorded.

Statistical Analysis

NCSS (Number Cruncher Statistical System) Statistical Software (Utah, USA) program was used for statistical analysis. While evaluating the study data, in addition to descriptive statistical methods (mean, standard deviation, median, frequency, ratio), the Shapiro-Wilk test and box plot graphics were used to ensure that the variables fit into a normal distribution. Student's t-test was used for intergroup comparisons of normally distributed variables; Mann Whitney U test was used for intergroup comparisons of variables that did not show normal distribution. Pearson's Chi-square, Fisher's exact, and Fisher-Freeman Halton tests were used to compare qualitative data. Significance was evaluated at $p<0.05$ level.

RESULTS

Demographic Data

Between 2016 and 2022, a total of 304 patients, including 181 male (59.54%) and 123 female patients (40.46%), were diagnosed with patella fractures. The male-female ratio was 1.48:1. The average age is 46±19 years.

Age distribution was examined by dividing into 4 groups; 0-15, 15-30, 30-65, and over 65. While patella fractures were seen in eight patients under the age of 15, patella fractures were observed in seventy-two patients between the ages of 15-30, hundred and sixty-seven patients between the ages of 30-65, and fifty-seven patients over the age of 65 (Table 1).

Table 1. Relationship between age and gender distribution

		Gender		
		Male, n (%)	Female, n (%)	p
Age	0-15 ages	5 (2.76)	3 (2.44)	0.0001
	15-30 ages	57 (31.49)	15 (12.2)	
	30-65 ages	93 (51.38)	74 (60.16)	
	Over 65	26 (14.36)	31 (25.2)	

Considering seasonal differences, fractures were most common in winter (35.2% n=107), while 83 (27.3%) patella fractures were diagnosed in summer, 66 (21.7%) in spring, and 48 (15.8%) in autumn. Although no significant data was found regarding the relationship between age and seasons, emergency service admissions with a history of trauma were seen mostly in the winter (38.92%) in the 30-65 age group, where fractures are most common (Table 2).

While high-energy injuries were most frequently observed in male patients (68%, n=54), the most common cause of fracture formation in male patients was low-energy injuries (70.2%). In female patients, 98 (79.7%) of patella fractures were caused by low-energy injuries and 25 (20.3%) were caused by high-energy injuries (Table 3).

The presence of accompanying extremity (lower and upper limb injury) and visceral (local, cranial, thoracal, and abdominal) injuries after the trauma was presented. 30 (9.87%) patients with patella fractures had an accompanying extremity fracture. Of these, 16 (5.26%) were lower and 14 (4.61%) were upper extremity fractures. Three major cavity and local injuries were seen in 21 patients (6.91%) (Table 2). No significant difference was observed regarding the location of the accompanying fracture. Still, the incidence of the isolated patella fracture was significantly higher ($p<0.05$). The presence of accompanying injuries was found to be significantly higher in high-energy injuries ($p<0.05$) (Table 2).

Patella fractures were classified by descriptive classification[3] and AO classification.[11] The most common was transverse fractures (AO C1 subtype) ($p<0.05$) (Table 2). When the fracture type and trauma mechanism were compared, although the rate of comminuted fractures increased in high-energy traumas, no significant difference was observed. ($p>0.05$) While it was observed that gender, trauma day, and season did not cause a significant change in fracture type, a significant relationship was found between fracture type and AO classification and age group. ($p=0.0001$) While avulsion (AO 34-A1) and osteochondral fractures were most frequently observed in the group under 15 years, transverse (AO 34-C1) fractures were most frequently observed in the 30-65 age group, and the patient group over 65 years of age (Table 2).

While 251 (82.57%) patients were followed non-operatively, 53 (17.43%) patients underwent surgical treatment. 58.96% (n=148) of male patients and 41.04% (103) of female patients were treated conservatively (long leg cast/splint and knee braces). There was no relationship between gender and treatment method ($p>0.05$).

Table 2. Sociodemographic data of patella fractures, analysis of concomitant injuries, and distribution of fractures according to descriptive (morphological) and AO classifications

		n	%
Gender	Male	181	59.54
	Female	123	40.46
Trauma side	Right	152	50
	Left	148	48.68
	Bilateral	4	1.32
Trauma mechanism	Simple falls	225	74.01
	Traffic accident	45	14.8
	Gunshot injury	10	3.29
	Falling from high	24	7.89
Trauma day	Monday	52	17.11
	Tuesday	33	10.86
	Wednesday	49	16.12
	Thursday	34	11.18
	Friday	33	10.86
	Saturday	43	14.14
	Sunday	60	19.74
Season	Spring	66	21.71
	Summer	83	27.3
	Autumn	48	15.79
	Winter	107	35.2
Accompanying fracture	No	274	90.13
	Upper extremity	14	4.61
	Lower extremity	16	5.26
Presence of non-musculoskeletal injury	No	283	93.09
	Yes	21	6.91
Additional injuries	No	283	93.09
	Cranial	5	1.64
	Thoracal	4	1.32
	Abdominal	1	0.33
	Local soft tissue	11	3.62
Definitive fracture classifications	1	28	9.21
	2	70	23.03
	3	60	19.74
	4	31	10.2
	5	31	10.2
	6	52	17.11
	7	32	10.53
AO/OTA classifications	A1	49	16.12
	A2	30	9.87
	B1	34	11.18
	B2	21	6.91
	C1	96	31.58
	C2	27	8.88
	C3	47	15.46

AO: Arbeitsgemeinschaft für osteosynthesefragen, OTA: Orthopaedic Trauma Association

Table 3. Relationship of age, day of trauma, trauma mechanism, and season with gender

		Gender		
		Male, n (%)	Female, n (%)	p
Age	Under 15	5 (2.76)	3 (2.44)	0.0001
	15-30 ages	57 (31.49)	15 (12.2)	
	30 65 ages	93 (51.38)	74 (60.16)	
	Above 65	26 (14.36)	31 (25.2)	
Trauma day	Monday	25 (13.81)	27 (21.95)	0.021
	Tuesday	17 (9.39)	16 (13.01)	
	Wednesday	37 (20.44)	12 (9.76)	
	Thursday	24 (13.26)	10 (8.13)	
	Friday	17 (9.39)	16 (13.01)	
	Saturday	21 (11.6)	22 (17.89)	
	Sunday	40 (22.1)	20 (16.26)	
Trauma mechanism	Simple falls	127 (70.17)	98 (79.67)	0.127
	Traffic accident	29 (16.02)	16 (13.01)	
	Gunshot injuries	9 (4.97)	1 (0.81)	
	Falling from high	16 (8.84)	8 (6.5)	
Trauma season	Spring	39 (21.55)	27 (21.95)	0.670
	Summer	54 (29.83)	29 (23.58)	
	Autumn	27 (14.92)	21 (17.07)	
	Winter	61 (33.7)	46 (37.4)	

A significant relationship was found between gender and age. However, no significant relationship was found between season and trauma mechanism. Fractures were most common in the 30-65 age group in both male and female patient groups, with the highest frequency of trauma occurring on sunday (Table 4).

Two patients from the conservative and seven from the operative treatment have suffered complications. One of the patients followed non-operatively developed extensor mechanism failure after delayed union, and the other developed moderate patellofemoral (PF) arthrosis. While mild-moderate PF arthrosis was observed in 3 patients with multi-fragmented displaced (AO 34-C3) fractures who underwent surgery, subacute osteomyelitis was observed in 1 patient with type 1 open injury. Bursitis and implant irritation were observed in 3 patients. Hardware removal was applied to all these 7 patients.

Although no significant relationship was observed according to the distribution of patella fractures over the years, an increase in the number of fractures was observed until the pandemic period (2020), although this increase stopped due to the lockdown effect during the pandemic period, a decrease in the incidence of fractures was detected, and the increasing trend continued after the pandemic (Table 5).

DISCUSSION

The subcutaneous location and limited soft tissue coverage of the patella, and its direct articulation with the distal femur may lead to articular cartilage damage, skin problems,

Table 4. Comparison of AO classification with gender, trauma mechanism, day of trauma, season of trauma, and age distribution

		AO							
		A1	A2	B1	B2	C1	C2	C3	
		n	n	n	n	n	n	n	p
Gender	Male	33 (67.35)	22 (73.33)	20 (58.82)	14 (66.67)	47 (48.96)	16 (59.26)	29 (61.7)	0.20
	Female	16 (32.65)	8 (26.67)	14 (41.18)	7 (33.33)	49 (51.04)	11 (40.74)	18 (38.3)	
Trauma mechanism	Simple falls	37 (75.51)	23 (76.67)	27 (79.41)	14 (66.67)	69 (71.88)	19 (70.37)	36 (76.6)	0.89
	Traffic accident	8 (16.33)	2 (6.67)	4 (11.76)	6 (28.57)	15 (15.63)	5 (18.52)	5 (10.64)	
	Gunshot injury	1 (2.04)	2 (6.67)	0 (0)	0 (0)	3 (3.13)	1 (3.7)	3 (6.38)	
	Falling from high	3 (6.12)	3 (10)	3 (8.82)	1 (4.76)	9 (9.38)	2 (7.41)	3 (6.38)	
Trauma day	Monday	9 (18.37)	2 (6.67)	4 (11.76)	3 (14.29)	14 (14.58)	8 (29.63)	12 (25.53)	0.65
	Tuesday	5 (10.2)	3 (10)	9 (26.47)	2 (9.52)	11 (11.46)	1 (3.7)	2 (4.26)	
	Wednesday	10 (20.41)	6 (20)	4 (11.76)	2 (9.52)	17 (17.71)	2 (7.41)	8 (17.02)	
	Thursday	5 (10.2)	4 (13.33)	3 (8.82)	2 (9.52)	13 (13.54)	1 (3.7)	6 (12.77)	
	Friday	7 (14.29)	2 (6.67)	3 (8.82)	3 (14.29)	11 (11.46)	4 (14.81)	3 (6.38)	
	Saturday	4 (8.16)	6 (20)	5 (14.71)	2 (9.52)	13 (13.54)	5 (18.52)	8 (17.02)	
	Sunday	9 (18.37)	7 (23.33)	6 (17.65)	7 (33.33)	17 (17.71)	6 (22.22)	8 (17.02)	
Season	Spring	9 (18.37)	9 (30)	2 (5.88)	4 (19.05)	21 (21.88)	5 (18.52)	16 (34.04)	0.164
	Summer	15 (30.61)	9 (30)	7 (20.59)	5 (23.81)	23 (23.96)	12 (44.44)	12 (25.53)	
	Autumn	8 (16.33)	3 (10)	9 (26.47)	2 (9.52)	17 (17.71)	1 (3.7)	8 (17.02)	
	Winter	17 (34.69)	9 (30)	16 (47.06)	10 (47.62)	35 (36.46)	9 (33.33)	11 (23.4)	
Age group	Under 15	5 (10.2)	2 (6.67)	0 (0)	0 (0)	1 (1.04)	0 (0)	0 (0)	0.0001
	15-30 ages	15 (30.61)	13 (43.33)	9 (26.47)	8 (38.1)	11 (11.46)	7 (25.93)	9 (19.15)	
	30-65 ages	25 (51.02)	13 (43.33)	16 (47.06)	12 (57.14)	57 (59.38)	16 (59.26)	28 (59.57)	
	Above 65	4 (8.16)	2 (6.67)	9 (26.47)	1 (4.76)	27 (28.13)	4 (14.81)	10 (21.28)	

AO: Arbeitsgemeinschaft für osteosynthesefragen

Table 5. Numbers and percentages of the cases treated conservatively and surgically by year

		Treatment			
		Conservatively		Surgical	
		n	%	n	%
Year	2016	22	8.76	10	18.87
	2017	33	13.15	6	11.32
	2018	39	15.54	5	9.43
	2019	58	23.11	7	13.21
	2020	27	10.76	4	7.55
	2021	39	15.54	8	15.09
	2022	33	13.15	13	24.53

extensor mechanism insufficiency, and even arthrosis (12-14). Therefore, although relatively rare, the nature of patella fracture, treatment options, functional results, and possible complications should be predictable. The current literature has limited data on the etiology and epidemiology of patella fractures in large populations in Turkiye. The most important finding of the study is providing a detailed analysis, which is limited in the literature and exceptional in our region, on a relatively large sample that included comprehensive data from a level-1 trauma center.

In a Korean study on the characteristics of patella fractures between 2003 and 2017, an increased incidence was found in female and elderly patients.[1] Begnér et al.[15] reported a serious increase in patella fractures, especially in female patients, from the 1950s to the 1980s. Another study emphasized that the gender distribution of patella fractures was more balanced.[16] Similarly, in our study, although there was an increasing trend in patella fractures in middle and older ages, a pause and regression were detected in this trend due to the pandemic era. No difference was detected in gender. Unlike the current literature, our data differs from other studies because it includes the COVID-19 pandemic period and reflects the projection of this period.

While comminuted and displaced fractures are more common in male patients due to higher-energy injuries, transverse fractures are more common in female patients due to low-energy traumas.[9,17] In our study, consistent with the literature, transverse fractures were the most common in both genders. This can also be explained due to the high-energy traumas are more common in males (29.83% vs. 20.33%). Low-energy traumas are more common in females (79.67% vs. 70.17%).

Patella fracture classification is essential for treatment management, and computed tomography (CT) is frequently used to both understand the fracture pattern and detect possible additional periarticular pathologies.[18]

In a large series conducted in Sweden, horizontal simple (AO 34-C1) fractures were the most common, while lateral vertical

(AO 34-B1) fractures were the second most common.[9] Larsen et al.[17] reported similar results with a rate of 23.2% for C1 fractures and 25% for C3 fractures. In our study, similar to the literature, C1 fractures were the most common (31.58%), while A1 fractures (16.12%) came in second, unlike the literature.

A1 fractures were most seen between the ages of 15-30 because of low-energy trauma such as sports injuries. In patients under 15 years of age, the most common type of fracture was A1 (62.5%), and the most common osteochondral fractures (type 7) were observed in this group with a frequency of 37.5%. It may be caused by osteochondral fractures that may accompany patellar dislocation secondary to sports injuries or simple falls in adolescence.

The high-energy injury rate (26.99%) was similar to other studies.[9,17] Most of these fractures were comminuted fractures. The most common mechanism of injury, a simple fall, is also consistent with other studies.

Our conservative treatment rate was 82.57%, which was higher than the literature (66.9%-74%).[9,19] In addition to possible differences in clinical habits and approaches, the potential contribution of the increased non-operative attitude during the pandemic lockdown era may also be effective. Especially in 2020, our conservative treatment rate during the beginning of the pandemic was above the literature average of 85.2%. Although there is no data in the literature on the effect of the pandemic period on patella fractures, the approximately 30% decrease in surgical treatment rates reported in Japan in 2020 supports our hypothesis.[20]

There are different publications on fracture incidence, surgical treatment rates, and clinical outcomes during the pandemic.[21-23] For instance, although Olech et al.[23] reported a decrease in the number of patients with distal radius fractures, the surgical incidence was higher than pre-pandemic period. On the other hand, Rojoa et al.[22] presented increased domestic falls and similar optimized rates of hand trauma management during the pandemic. In contrast, Klepacki et al.[21] mentioned a prolonged interval for therapeutic intervention and chanced ratios between adult and pediatric ankle injuries. In addition, there have been changes in injury mechanisms. In the lockdown era, accidents due to domestic trauma and motorcycle traffic increased, while a decrease in work and sports injuries was observed.[24] This variability in the etiology, epidemiology, treatment processes, and preferences of trauma patients was also highlighted in our study and supports our hypothesis.

Additionally, Rau et al.[25] examined national data from 2006 to 2020 and found that there has been an increasing trend toward surgical treatment. In contrast, although there was no continuous increase during the pandemic period, it is seen that the rate of surgical treatment increased towards the end of the pandemic. However, the indications for surgical treatment are controversial, except for definitive indications.

Of the surgically treated cases, 43.1% were classified as AO C1 and 32.1% as AO C3. A surgical treatment trend was observed in comminuted fractures. Due to increasing surgical preferences, complications were most frequently observed in this group. Increased risk for knee arthroplasty and lower healthy quality of life are reported in patients with patella fractures.[7,8]

In their study, Larsen et al.[26] reported the complication rate of conservative treatment as 4% and surgical treatment as 57%. In another study, the complication rate was found to be 6.8% in patients who underwent surgical treatment.[1] In our study, while it was 0.8% in conservative treatment, it was found to be 13.21% in surgical treatment. Although we think that various factors such as fracture type, surgical technique, and demographic characteristics impact this difference, we think that the age factor is an important factor. While the average age in our study was 46, it was 66.8 in Larsen et al.'s[26] study, which had a high complication rate.

In a meta-analysis by Vesterager et al.,[10] it was reported that the most common complication of surgically treated patellar fractures was implant irritation which affected approximately one-third of the patients. This is followed by implant failure, infections, and a less common nonunion.

Due to the subcutaneous location of the patella and limited soft tissue coverage, implant irritation is observed especially after open surgical procedures.[27] Implant preferences and applications are gaining importance. The need for implant removal is high in patients who have tension band application due to pain or mechanical irritations.[28] In the literature, the rate of persistent pain after tension tape application has been reported in the range of 10-50% (14,29,30). It has also been shown that the use of Kirschner wire requires twice more implant extraction than screw application.[29] In our study, the implant was removed in all 7 patients (13.21%) with surgical complications. However, the tension band technique is still a popular fixation method for comminuted fractures.

Limitations

The retrospective nature of the study and being a single-center study are limitations. It is a strength in terms of providing detailed data on a globally and locally arid subject with six years of data including the COVID-19 pandemic period.

CONCLUSION

The incidence of patella fractures has been increasing over the years. Most patients are treated conservatively. Attention should be paid to the high complication rates in surgically treated patients. Our study presents comprehensive etiological and epidemiological data. Finally provides a better understanding of the projection of patella fractures in Turkiye.

The study is unique in showing the potential effects of the COVID-19 Pandemic and lockdown era on the patient profile and treatment management of patella fractures. Multicenter studies with long follow-up periods, including large patient pools, are necessary to provide more appropriate etiological and epidemiological data.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethics Committee (Date: 05.08.2024, Decision No: 2024-07-).

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 authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

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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