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Research Article / Araştırma Makalesi

Injury mechanism of patellar dislocation in professional athletes: a video analysis study

Profesyonel sporcularda patellar çıkığın yaralanma mekanizması: video analiz çalışması

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ABSTRACT

Objective: Patellar dislocation (PD) is a devastating injury in professional athletes. An important aspect of injury prevention requires not only identifying the risk factors but also determining the responsible injury mechanism. Therefore, this study aimed to evaluate the injury mechanisms by examining the videos of PD injuries that occurred in professional athletes.

Material and Methods: Injury videos of identified athletes and/or sports competitions where the injury occurred were detected on social media platforms (YouTube®, Twitter®, Facebook®). On January 1, 2021, 32 patella dislocation videos were found. A total of 28 PD that occurred in professional athletes between 1999 and 2020 were identified. Of these, 18 PD injuries with adequate video data were analyzed for injury mechanism, body posture, and player and sports characteristics. Three independent reviewers evaluated the videos.

Results: There were 17 (94.4%) male and 1 (5.6%) female athletes. The mean age was 26.2±3.1 years. Distribution of athletic branches were such: four basketball (22.2%), two football (11.1%), nine rugby (50.0%), two soccer (11.1%), and one boxing (5.6%). In 13 cases (72.2%), the injury occurred by contact mechanism. Eight of these injuries (61.5%) occurred as a result of direct contact. The most important findings of this study were that patellar dislocation occurred when the trunk, hip, knee and ankle were slightly flexed. Dislocation occurred with the contraction of the quadriceps while the foot and tibia were performing external rotation.

Conclusion: In professional athletes, PD most frequently occurs during a collision. The most common posture of the athlete who lost his balance is the trunk in flexion, knee and hip in flexion, ankle in plantar flexion.

Keywords: *Patellar dislocation, professional athlete, injury mechanism, body posture, prevention*

ÖZ

Amaç: Patella çıkığı (PÇ), profesyonel sporcularda oldukça yıkıcı bir yaralanmadır. Yaralanmayı önlemenin önemli bir yönü, yalnızca risk faktörlerinin tanımlanmasını değil, aynı zamanda sorumlu yaralanma mekanizmasının da belirlenmesini gerektirir. Bu nedenle bu çalışmada profesyonel sporcularda meydana gelen PÇ yaralanması videolarının incelenerek yaralanma mekanizmalarının değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Profesyonel sporcularda 1999-2020 yılları arasında meydana gelen toplam 28 PÇ belirlendi. Bunlardan yeterli video verisine sahip 18 PÇ yaralanması; yaralanma mekanizması, vücut pozisyonu, oyuncu ve spor özellikleri açısından analiz edildi. Videolar üç gözlemci tarafından değerlendirildi.

Sonuçlar: Toplamda 17 (%94.4) erkek ve 1 (%5.6) kadın sporcu vardı. Ortalama yaş 26.2±3.1 idi. Spor dallarının dağılımı ise; dört basketbol (%22.2), iki futbol (%11.1), dokuz ragbi (%50.0), iki Amerikan futbolu (%11.1) ve bir boks (%5.6) idi. Yaralanma 13 olguda (%72.2) kontakt mekanizma ile meydana geldi. Bu yaralanmaların sekizi (%61.5) direkt temas sonucu oluştu. Bu çalışmanın en önemli bulgularına göre patella çıkığı; gövde, kalça diz ve ayak bileği hafif fleksiyonda iken meydana gelmekteydi. Ayak ve tibia dış rotasyon hareketi yaparken kuadrisepsin kasılmasıyla birlikte çıkık oluşmaktaydı.

Sonuç: Profesyonel sporcularda PÇ en sık bir çarpışma sırasında ortaya çıkar. Çarpışma sonrası dengesi bozulan sporcunun en sık karşılaştığı pozisyonda; gövde, diz ve kalça fleksiyonda, ayak bileği plantar fleksiyondadır.

Anahtar Sözcükler: *Patella çıkığı, profesyonel sporcu, yaralanma mekanizması, postür, korunma*

INTRODUCTION

Patellar dislocations are important injuries with poor prognostic potential (1). Patellar dislocation and the resulting patellar instability can lead to significant pain, recurrence, and even patellofemoral osteoarthritis (2). An important aspect of injury prevention requires not only identifying the risk factors but also determining the underlying injury mechanism. By identifying the mechanism of injury, it is possible to develop proper injury prevention programs and rehabilitation protocols (1). However, there is much controversy in the literature regarding the mechanism of patellofemoral dislocation (1,3-13).

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Systematic video analysis has been used to gather information about posture at the time of injury, and the movements of an individual. It has been used as a reliable method for determining mechanisms of different sports injuries (10,14). To the best of our knowledge, there is no video analysis study investigating the injury mechanism of patellofemoral dislocations in athletic and non-athletic patellar dislocation patients. However, in the study by Dewan et al., there were videos of non-professional athletes (n=13) (10). The present study has the feature of considering the injury videos of professional athletes, and to be the video analysis study with the largest sample size. In addition, it is the first to evaluate the position of the trunk at the time of injury. Therefore, in this study, we aimed to reveal the injury mechanisms by examining videos of patellar dislocation injuries that occurred in professional athletes. In addition, body posture at the time of injury varies among different sports. Identifying the injury mechanism of patellofemoral dislocation in professional athletes can help prevent injury.

MATERIAL and METHODS

Injury videos of the identified athletes and/or sports competitions where the injury occurred were detected on social media platforms (YouTube®, Twitter® and Facebook®). On January 1, 2021, 32 patella dislocation videos were reached. Inclusion criteria were determined as the verification of patellar dislocation on public media platforms, the image at the time of injury to include the foot, ankle, knee, hip and entire body, and the video to have an image quality that could detect the mentioned body parts (Fig. 1-5). Exclusion criteria were determined as not verifying two professional athletes' injuries, six insufficient images, six insufficient video quality, and injuries whose accuracy was not proven. Player data and statistics (age, sex, year of injury, month of injury, season loss, career termination, and match numbers) were collected using public databases (15-19). The methodology of the study was previously used in various studies (10,20,21). All the videos that we accessed are publicly available, and data were treated confidentially. No personal player information was accessed; thus, similarly to previous studies, ethical permission was not required.

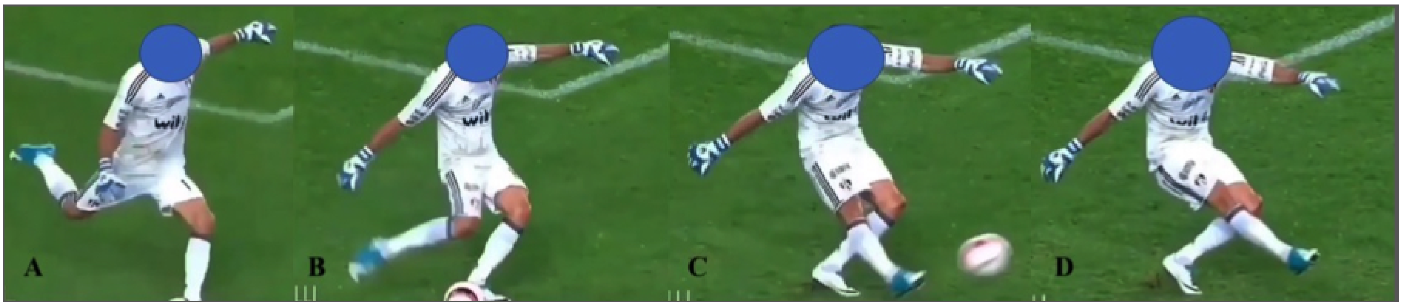

Figure 1. (A) The player puts his left foot as support; (B) The degree of flexion of the athlete's supporting leg reaches approximately 90°; (C) Image of patella dislocation; (D) Patellar dislocation more evident in the last moment of injury.

Figure 2. (A) The moment when the player in the red shorts receives a blow to the left knee in a rugby match; (B) The knee being forced into valgus with the blow; (C) View of patellar dislocation development from a different camera; (D) Image of spontaneous reduction of the patellar dislocation.

Figure 3. (A) Beginning of injury to the right knee of the athlete in black shorts; (B) Moment of defense action of the athlete in red shorts; (C) The patella dislocates while the knee is flexed when falling; (D) Ending phase of injury as patella dislocation develops.

Figure 4. (A) Onset of injury that develops in the left knee of the athlete wearing white shorts; (B) The moment when the left lower extremity is in contact with the ground as the knee is forced into flexion and valgus; (C) The development of patellar dislocation following the challenge; (D) Image of patellar dislocation developing in the left knee.

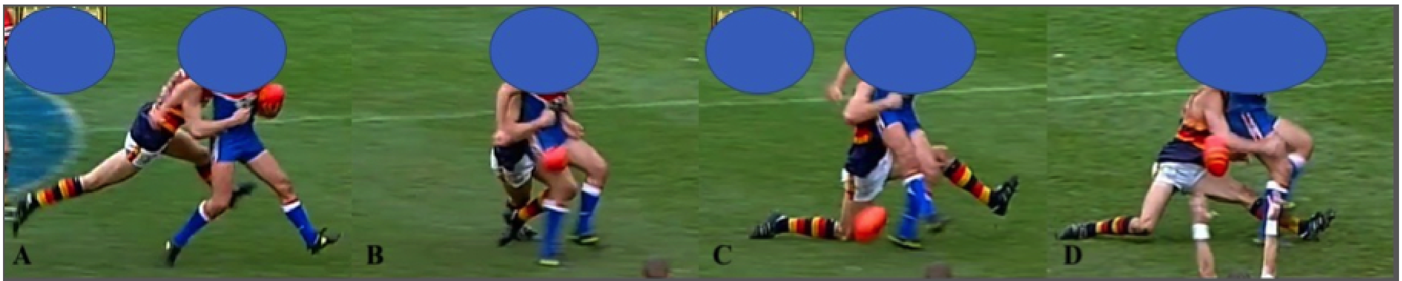

Figure 5. (A) Right patella dislocation developed during a rugby match as the back player catches his opponent; (B) The moment before the right knee hits the ground during continuation of the movement; (C) Patella comes out with ground impact; (D) Dislocation with direct blow.

The mechanism of injury was analyzed in the following two categories: non-contact and contact injuries. Contact injuries are divided into direct and indirect ones (21). Videos were viewed at a speed 0.25 times slower than original. The above-mentioned authors examined the presence of contact, play activity at the time of injury (takeoff/acceleration, jump descent, jump, and stop/ turn), body position (neutral, flexion, and extension), body tilt (ipsilateral and contralateral), bodyrotation (ipsilateral and contralateral), coronal hip position (neutral, abduction, and adduction), sagittal hip position (neutral, flexion, and extension), hip rotation (neutral, internal, and external), sagittal knee position (neutral, flexion, and extension), coronal knee position (neutral, varus, and valgus), sagittal ankle position (neutral, dorsiflexion, and plantar flexion), coronal position of the heel (neutral, varus, and valgus), and position of the foot (neutral, pronation, and supination). The videos consisted of one or more of the coronal, sagittal and oblique angles. All three authors blindly evaluated the videos twice a month. Data were analyzed for all athletes and their individual sports branches.

In this study, the IC Measure (v2.0.0.286) program was used for video analysis (22). In nine videos, measurements were made in both the sagittal and coronal planes. Measurements were made in the sagittal and coronal planes in 14 and 11 videos, respectively. Other images were not used in this analysis because they had oblique views from different angles and may have provided incorrect information for angle measurements. Measurements were performed by three authors, and the average was calculated.

Intra-and inter-observer agreements were investigated using Fleiss kappa (k) statistics for categorical data. The inter-observer agreement percentages were calculated by dividing the number of occasions of complete agreement by the total number of occasions. The results were interpreted as follows: <0.00, poor agreement; 0.00-0.20, slight agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; and 0.81-1.00, almost perfect agreement. Statistical significance was set at $p<0.05$. SPSS® v23.0 was used for statistical analysis.

RESULTS

There was almost perfect intra- (k>0.850) and inter-observer (k>0.831) agreement with regards to the categorical variables. There were 17 male and one female athlete, and their mean age was 26.2±3.1 years. The right and left sides were injured in eight (44.4%) and ten (55.6%) athletes, respectively. The distribution of athletic branches was as follows: four basketball players (22.2%), two football players (11.1%), nine rugby players (50.0%), two soccer players (11.1%), and one boxer (5.6%). In 13 athletes (72.2%), the injury occurred via a contact mechanism. Eight (61.5%) of these injuries were caused by direct contact with the knees. The distribution of injuries per month was similar. Contraction of the quadriceps muscle was observed in all athletes from the moment of dislocation. The game activity at the time of injury is summarized in Table 1, and the features of video analysis of the mechanism of injury are summarized in Tables 2 and 3.

Table 1. Game activities and distribution at the time of injury

Activity	Number of cases	Distribution (%)
Collision	10	55.6
Stop / rotate	5	27.8
Landing	3	16.6
Total	18	100.0

Table 2. Distribution of body parts' positions and proportions according to video analysis

Anatomical part	Position	Position of movement relative to planes	Number of cases(n)	Distribution of cases (%)
Trunk	Trunk position	Neutral	5	27.8
		Flexion	9	50.0
		Extension	4	22.2
	Trunk tilt	Neutral	13	72.2
		Ipsilateral	3	16.7
		Contralateral	2	11.1
	Trunk rotation	Neutral	11	61.1
		Ipsilateral	2	11.1
		Contralateral	5	27.8
Hip	Hip position (sagittal)	Neutral	2	11.1
		Flexion	15	83.3
		Extension	1	5.6
	Hip position (coronal)	Neutral	13	72.2
		Abduction	4	22.2
		Adduction	1	5.6
	Hip rotation	Neutral	14	77.7
		Internal	1	5.6
		External	3	16.7
Knee	Knee positiongittal)	Flexion	18	100
		Extension	0	0.0
	Knee position (coronal)	Neutral	4	22.2
		Varus	7	38.9
		Valgus	7	38.9
Ankle	Ankle position (sagittal)	Neutral	5	27.8
		Plantarflexion	8	44.4
		Dorsiflexion	5	27.8
	Ankle position (coronal)	Neutral	7	38.9
		Varus	4	22.2
		Valgus	7	38.9
Foot	Foot position	Neutral	5	27.8
		External rotation	7	38.9
		Internal rotation	6	33.3

DISCUSSION

The most important findings of this study were that patellar dislocation occurred when the trunk, hip, knee and ankle were slightly flexed. Dislocation occurred with the contraction of the quadriceps while the foot and tibia were performing external rotation. In 72.2% of the athletes, the injury occurred via a contact mechanism. Of these, 61.5% were caused by direct contact with the knee. The most common form of injury occurred after an athlete hit another athlete or a fixed object.

Table 3. Average angles at body and joint positions where injury is most common

Position	Number of cases (%)	Mean angle (°)
Trunk flexion	9 (50.0)	36.9
Hip flexion	15 (83.3)	68.6
Knee flexion	18 (100.0)	79.7
Ankle plantar flexion	8 (44.4)	30.2

The stability of the patellofemoral joint is provided by the complex interaction of muscle, soft tissue, and joint geometry (23). A complex mechanism is required for patellar dislocation in an anatomically normal knee (1). Clinical examinations and medical imaging provide valuable information about patellofemoral joint anatomy. However, in such a complex dynamic system, these methods alone are not sufficient to establish cause-and-effect relationships. The poor long-term functional outcomes of current treatments highlight the need for a better understanding of the patellar dislocation mechanism (1,10,24). Video analysis in determining injury mechanism may prove previously determined theoretical models to be misleading (10,25). This is the second study in the literature to include video analysis of patellofemoral dislocation injuries. It also provides new information as it includes only elite athletes and highest number of cases compared with all similar studies.

The study of Dewan et al. suggest that the patella's movement is lateral by approximately 20°. This supports the mechanism by which dislocation occurs predominantly in the early phase flexion (1). In many studies, it has been emphasized that patellar dislocation is accompanied by valgus stress, as well as knee flexion (2,4,7,9,10). Considering that knee valgus stress may contribute to patellar lateralization, a maneuver to prepare the grounds for patellar dislocation would be a logical idea. However, in our study, varus and valgus stress were equally accompanied by patellofemoral dislocation.

Non-contact injuries are the most common cause of patellar dislocation. However, contact patellar dislocations are more common among male athletes in general (25). In our study, 68.4% of athletes had been injured through a contact mechanism. Considering the contact injury density in our study, power transferred by trauma to the patellofemoral joint in a contact type dislocation mechanism may be a more effective cause of stress than the coronal plane position of the knee created in the patellofemoral joint.

Patellofemoral dislocation is accompanied by hip flexion (10). Simultaneously, internal rotation of the femur is accepted as part of the mechanism by which a lateral patellar dislocation occurs (1,3,7). Dewan et al. reported that evidence of femoral internal rotation is uncertain and emphasized that more work is needed (1). We found that hip internal rotation accompanied patellar dislocation in only 5.3% of the athletes. In most athletes, the hip was in a neutral position in the axial plane during dislocation. Hughston assumed that the foot makes a sharp plantar movement in the opposite direction at the time of injury (3). During the external rotation of the tibia, if the foot is fixed to the ground, the patella may dislodge without any pathological structure in the patellofemoral joint (7). In our study, the plantar flexion of the foot was often fixed in the position and on the ground. We determined that it came to external rotation, which may contribute to lateralization of the patella by causing external rotation of the tibia.

To our knowledge, there is no information in the literature regarding the trunk position during patellofemoral dislocation. Control of trunk position in the sagittal plane can play an important role in the anterior cruciate ligament (ACL) injury as it is important to balance control (26). The importance of trunk control in ACL injury has been demonstrated in skiing by the phantom foot mechanism that partially links the ACL injury to a strong quadriceps' contraction (27). Our observations suggested that most athletes lost their balance with contact and tried to maintain it by tilting their body forward and flexing their hips. Patellar dislocation occurred with the contraction of the quadriceps, with the knee under load.

Most patellofemoral dislocations occur under the age of 20 (2); however, the average age in our study was higher. The fact that an adult professional player does not experience dislocation in the early professional period may be due to the absence of anatomical risk factors that cause dislocation. In this case, dislocation of the traumatic ground may have occurred in the older age group. This situation can be demonstrated by comparing it in a study with a large number of cases involving high school athletes.

This study had several limitations. Factors, such as the type of surgical treatment of athletes, presence of osteochondral injury, surgical treatment method, and duration and characteristics of postoperative rehabilitation are unknown. Additionally, the risk factors for patellofemoral dislocation in these athletes are unknown. As the injury data were obtained from public records, they may not be 100% accurate, and we may not be able to verify that every athlete assessed having an acute patellar dislocation during the study period to have patellofemoral dislocation or a first dislocation. However, similar methods have been used and accepted in many previous studies (10,14). Another shortcoming that can be listed as a limitation is the video analysis. Because the videos were obtained from different platforms, video quality, camera angles, the distance the image was taken, and the number of views obtained from different angles were not the same. Owing to the lack of standardization, joint angles at the time of injury could not be measured via a video program or analyzed quantitatively by converting them into numerical values. Since positions at the time of emergence of the patella were defined, they could be evaluated qualitatively.

One of the important points is that most patellar dislocations occur with non-contact injuries (7,10,28). In most athletes in our study, the occurrence of injury is after contact, and the involvement of only one female athlete may cause bias. However, most contact-related dislocations are seen in male athletes (25). This could mean that our work on contact-related injuries could provide valuable information. However, since anatomical variations in the patellar dislocation mechanism are not very common in these professional athletes, it may also be the result of lack of patellar dislocation until they reach the professional league. This could explain the higher average age observed in our study than that reported in the literature, which mostly consists of traumatic dislocations. Despite these limitations, it is the first study in which video analysis of the trunk position in patellar dislocations was performed, involving only professional athletes and different sports branches. It provides valuable information, as it is the second video analysis study of patellar dislocations and includes the largest number of cases. In addition, this study is the first in the literature to evaluate the position of the trunk at the time of injury.

CONCLUSION

Patella dislocation occurs most frequently as a result of direct contact in professional athletes. The most common posture of the athlete who lost balance was the trunk in flexion, knee and hip in slight flexion, and ankle in plantar flexion. Dislocation occurred with contraction of the quadriceps, while the foot and tibia rotated externally. This information can be utilized to implement preventive measures.

Ethics Committee Approval / Etik Komite Onayı

Ethics committee approval is not needed due to publicly accessible data interpretation.

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

Financial Disclosure / Finansal Destek

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Author Contributions / Yazar Katkıları

Concept – AY,MY,AM; Design - AY,MY,AM; Supervision – AY; Materials – AY,MY,AM; Data Collection and/or Processing – AY,MY,AM; Analysis and Interpretation – AY,MY,AM; Literature Review – AY,MY,AM; Writing Manuscript , AY,MY,AM; Critical Reviews - AY,MY,AM

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