

Injuries Requiring Surgery in Folk Dancers: A Retrospective Cohort Study of 9 Years

Neslihan Aksu¹, Vefa Atansay¹, Taner Aksu², Safiye Koçulu³, Sukriye Damla Kara⁴ and Işık Karalök⁵

1. Department of Orthopedics and Traumatology, Faculty of Medicine, Istanbul Bilim University, Abide i Hurriyet Cad No 164 Şişli 34381, Istanbul, Turkey

2. Department of Orthopedics and Traumatology, Medical Faculty, Bahcesehir University, Medical Park Hospital Fevzipaşa mah Dolap cad. Fatih, Istanbul, Turkey

3. Department of Clinic Microbiology and Infectious Disease, Faculty of Medicine, Istanbul Bilim University, Abide i Hurriyet Cad No 164 Şişli 34381, Istanbul, Turkey

4. Department of Neurology, University of South Florida, FL 33606, USA

5. Radiology Department, Faculty of Medicine, Istanbul Bilim University, Abide i Hurriyet Cad No 164 Şişli 34381, Istanbul, Turkey

Abstract: Background: In this study, we examined professional folk dancer injuries which required surgery and if there are any associated factors like age, gender, dexterity, dance style and to evaluate the return to their full capacity. Materials and Methods: Seventy five members of the Fire of Anatolia dance group (mean age: 26.8 ± 5.2 ; 18-38 years) performers were evaluated. The dancers suffered 14 orthopedic injuries requiring surgery (3 meniscus tears, 2 anterior cruciate ligament tears one of which is with posterolateral corner tear, 1 posterior cruciate ligament tear, 1 patellar dislocation, 1 scaphoid fracture, 1 extensor tendon cut in hand, 1 infrapatellar bursitis, 2 Hoffa's fat pad syndromes, 2 symptomatic medial plicae) during a nine-year period. Follow-up time was 51 ± 41.9 (29.5-92) months. Results: Following surgeries, the dancers could restart rehearsals in 12.7 ± 9 (range: 4 to 36) weeks and perform live on the stage in 16.2 ± 12.2 (range: 5 to 52) weeks on average. Conclusion: Males were 8.64 times more likely to suffer an injury requiring surgery compared to the females ($p = 0.003$) and twelve (85.7%) of these injuries were lower extremity injuries and were all located in the knee in Anatolian folk dancers.

Key words: Dancer injuries, folk dancers, knee injuries, arthroscopy, return to dance, knee surgery.

1. Background

Dancer's injuries are much like sports injuries; however, they push the anatomical and physiologic limits to properly perform aesthetic choreographies. Dancers' injuries are multi-factorial; injuries may depend on the dancer, the dance pattern or the environment. Dancer-related factors are considered as difference in body anatomy, hyper-mobility, nutrition, sleep deprivation, lack of experience, lack of exercise and preconditioning, lack of pre-performance warm-ups, and early return to activity after injuries

Corresponding author: Neslihan Aksu, M.D., associate professor, research fields: arthroscopic surgery and sports medicine.

[1-7]. Environmental factors include poor dancing floors, improper fittings like shoes, costumes and materials. Dance-related factors mostly include excessive repetition of certain movements and choreographies [1-7]. Dancer's injuries are mostly related to overuse injuries in ballet and modern dance in the literature [4, 5, 8-12]. Anterior cruciate ligament (ACL) surgery is one of the most common procedures associated with dance injuries in the literature [13, 14].

Dance injuries in the literature mostly consist of the ballet [1-12, 15]. In this study, we examined the injuries that required surgery and their possible risk factors (age, gender, dexterity, dance style, dance figure) in a group of 75 professional folk dancers.

2. Patients and Methods

Folk dancers' injuries were retrospectively investigated in our archives dating between January 2009 and January 2018. We examined the 75 members of a professional folk dance group (mean age: 26.8 ± 5.2 , range: 18 to 38 years) and their injuries which required surgery throughout a nine years period. The dance group trains for 5 days a week for 6 hours a day and performs live for 4 days a week in a 90-minute show with two intermissions.

All of the dancers to be raised were recruited from random minor dance groups from the region and a thorough musculoskeletal examination was executed prior to their acceptance. All of the data were recorded at Istanbul Bilim University archives. Minor injuries were excluded from this study to be published as a separate paper. Injuries mostly happened during stage performances and were evaluated by the medical team in charge at the time. All of the injuries informed to our system and dancers with serious injuries were transferred to our clinic directly. Most of these injuries were non-contact injuries except one extensor tendon injury due to an accidental sword cut. This study was approved by Istanbul Bilim University ethics committee (ethics committee approval No: 12.04.2016/48-05). All subjects gave written informed consent.

Members of the main professional dance group are either raised from the junior dance group of the same group or professional dancers with experience and who

had been trained for four months with this group. This dance group trains for 5 days a week for 6 hours a day and performs live for 4 days a week in a 90-minute show with two intermissions. Majority of the dances comprise of the Anatolian folk (Horon, Roman, Oriental, Teke, Zeybek, Lezginka) dances. The group has been on the stage for 16 years and has a mean professional dance exposure of 7.47 ± 4.24 years.

3. Results

The dancers suffered 14 orthopedic injuries requiring surgery during a nine-year period. The group consisted of 38 female and 37 male dancers with a mean age of 25.3 ± 5.2 (range: 18 to 38 years) and 28.4 ± 5.7 (range: 22 to 38 years).

Injuries that did not required surgery are excluded and reported separately. Injuries were acute in 9 (64.2%) dancers (meniscal tear in three, ACL rupture in two, Posterior cruciate ligament (PCL) injury in one, acute patellar dislocation in one, zone V extensor tendon rupture of the hand in one, scaphoid fracture in one). Five (35.7%) patients needed surgery due to chronic conditions (two symptomatic medial plica, two fat pad impingement, one deep infrapatellar bursitis) (Table 1). All of the lower extremity injuries were encountered during the shows but the two dancers with hand and wrist injuries suffered during the rehearsals.

While one of the three meniscal tears (one bucket-handle tear) was repaired with arthroscopic inside-out 2.0 sutures (Covidien, Mansfield, MA, USA), the others (one flap tear, one horizontal tear) were

Table 1 Frequency of injuries that required surgery shown according to dance style and gender.

Surgery cases: n:14 (18.6% of total dancers)	Gender M: Male F: Female
Meniscus tear (n:3)	3M
ACL tear (one of which is with PLC tear) (n:2)	2M
PCL tear (n:1)	1M
Symptomatic medial plica (n:2)	2M
Acute patellar dislocation (n:1)	1F
Hoffa's fat pad impingement (n:2)	2 (1M, 1F)
Deep infrapatellar bursitis (n:1)	1M
Scaphoid fracture (n:1)	1M
Hand extensor tendon cut (n: 1)	1M

ACL: anterior cruciate ligament; PCL: posterior cruciate ligament; PLC: posterolateral corner of the knee.

repaired with arthroscopic surgery. The bucket-handle tear patient who was treated with the inside-out technique had another flap re-tear after four years of full performance and required another repair. The two ACL patients had to undergo arthroscopic anatomic autologous hamstring graft reconstruction. Posterolateral corner injury was treated with primary repair by suture anchors on the fibular head.

The patient also had a non-displaced tibial plateau fissure which healed spontaneously at the time. The dancer who suffered an ACL tear with PLC (posterolateral corner injury) injury developed arthrofibrosis after two months of follow-up and required arthroscopic debridement and release. A month later, closed manipulation of the same knee under general anesthesia had to be performed. Patellar dislocation was treated with open primary repair of the medial patellofemoral ligament. Scaphoid fracture was treated with closed Herbert screw fixation, and extensor tendon injury was treated with primary repair. Our dancer with PCL injury had autologous hamstring graft reconstruction.

Symptomatic medial plica was excised in two dancers, and one of them also had an adjacent chondral injury which was also repaired. An infrapatellar bursitis was removed by the open technique, and two Hoffa's fat pad impingement syndromes were treated with arthroscopic resection. All dancers were provided with physical therapy and rehabilitation.

All 75 dancers in the group were statistically assessed according to the type of injury, age, gender and dance style. Statistical Package for the Social Sciences (SPSS) v.17 (SPSS Inc., Chicago, IL, USA) statistical software was used in analyzing the study data. Descriptive statistics were expressed as mean \pm standard deviation (min.-max.) for continuous variables and as frequency (%) for categorical variables. Distribution of the variables was examined with the Kolmogorov-Smirnov test. The parametric independent samples *t*-test and non-parametric Mann-Whitney *U* tests were used in the analysis of

quantitative data. Comparison of the qualitative data was done with the chi-square test. Level of significance was set at $p < 0.05$.

Type of the injuries: Fourteen (18.7%) (12 male, 2 female; mean age: $30 \pm \text{sd}5.4$, range: 22 to 38 years) of the 75 dancers experienced injuries that surgery was indicated during the retrospective follow-up period of nine years. Twelve (85.7%) of these injuries were lower extremity injuries and were all located in the knee. The two upper extremity injuries (14.2%) were in the hand. And 64.2% of the injuries that required surgery were traumatic (three meniscal tears, two ACL/PLC injury, one PCL injury, one patellar dislocation, one scaphoid fracture, one extensor tendon cut of the hand), whereas 35.7% were overuse injuries (two Hoffa's fat pad impingement, two symptomatic medial plica, one infrapatellar bursitis).

Associated factors in injuries (age, sex, dominant side): Mean age of the 14 dancers at the time of surgery was 28.2 ± 5.5 (range: 21 to 38 years) whereas it was 26.03 ± 4.9 (range: 18 to 38 years) for the 61 dancers (81.3%) who did not experience an injury. There was no statistically significant difference between the mean ages of the dancers with and without injuries ($p > 0.05$). Mean period of performance in the group for the dancers with injuries that required surgery was 8.6 ± 4.5 (range: 4 to 17) years. The prevalence of injury due to dancing was 8.64 times higher in males when compared to females ($p = 0.003$). The dominant side in all of the injured dancers was the right side. The dominant side stated here is the foot dominance for the lower extremity injuries and hand dominance for the upper extremity injuries. Dancers usually land on their dominant foot which may indicate a more injury liability at that side while this was not the case. The injuries were equally distributed on the left and right sides. No statistical relationship was found between the dominant and the injured sides ($p > 0.05$).

Injury patterns associated with dance figures: Our dancers had meniscus tears following frequent squats and twists on single leg stances at Horon and Zeybek

dances. On the other hand ACL tears happened after jumps and landings at Caucasian (Lezginka jump) dances. PCL tear was also seen after Caucasian (Lezginka) dance landing. Spagat figure (Fig. 1) in Karsilama dance ended up with a patellofemoral dislocation in one dancer (Table 2).

The dancer described a twist of her knee due to a shoe-grip at the beginning of her spagat move during the karşilama dance (Fig. 1), followed by a severe pain. At her presentation, the patella was dislocated.

Reduction was performed under general anesthesia and the repair of the medial patellofemoral ligament was performed.

Injuries and postoperative times to return to dance: Follow-up time with the same clinic and same surgeon for the patients was 57 ± 41.9 (35.5-98) months. Following surgeries, the dancers could restart rehearsals in 12.7 ± 9 (range: 4 to 36) weeks and perform live on the stage in 16.2 ± 12.2 (range: 5 to 52) weeks on average (Table 3).

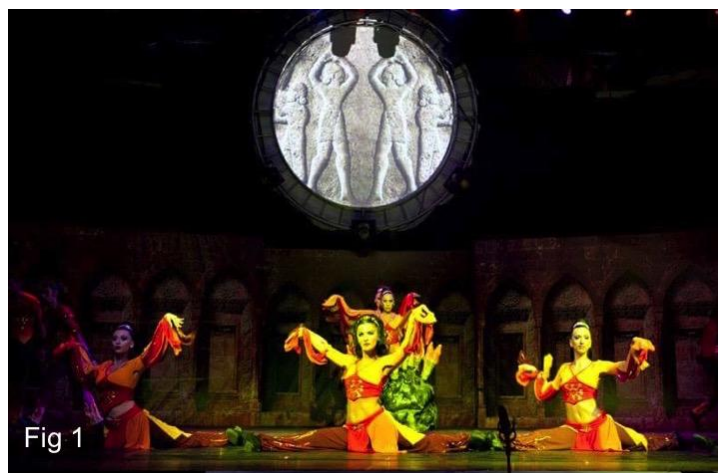


Fig. 1 Spagat figure. Spagat figure may lead to a patellafemoral dislocation in a patient without any prior patellofemoral problems.

Table 2 Dance figures that caused injuries in the group.

Anatolian folk dancers	Risky dance figures	Injuries
Horon	Fast squats and stand ups	Meniscus tear
Zeybek	Turning around on single foot stance	Meniscus tear
Kafkas (Lezginka)	Landing with Lezginka jump	ACL tear, PCL tear
Modern dance	Squats	Meniscus tear
Karsilama	Spagat	Patellofemoral dislocation

Table 3 Postoperative time for the dancers to return to rehearsals, live performance and follow-up times.

Injuries requiring surgery average (min.-max.)	Postoperative practice beginnings 12.7 ± 9 (4-36) weeks	Postoperative stage show 16.2 ± 12.2 (5-52) weeks	Follow-up time 39.5 ± 29.9 (17.5-80) months
Tendon cut	6	6	32
Scaphoid fracture	4	8	63.5
Meniscus tears	6.7 ± 4.6 (4-12)	8 ± 4.3 (5-13)	33.6 (23.5-44.5)
Bursitis	8	12	17.5
Symptomatic medical plicas	8	12 ± 5.6 (8-16)	33.5 (21-46)
Patellar dislocation	12	16	21
Hoffa’s fat pad impingements	17 ± 1.4 (16-18)	18 ± 1.4 (17-19)	38.7 (38.5-50)
PCL tear	20	21	49.5
ACL tears	29 ± 9.9 (22-36)	40 ± 16.9 (28-52)	62.5 (45-80)

The dancers who had upper extremity injuries (tendon cut and scaphoid fracture) could return to dance the earliest. The patient with a tendon cut could perform live after six weeks, and the other with a scaphoid fracture could perform live after eight weeks. Both dancers were allowed to bear weight on their hands 12 weeks after surgery.

Of those who had a knee surgery, the ones with a meniscal tear were the fastest to return to dance, followed by those with bursitis, medial plica, patella dislocation, fat pad impingement, PCL and ACL/PLC injuries. One modern ballet dancer could perform live eight weeks after an arthroscopic meniscal suture

procedure. Patients with meniscus repairs were able to perform loading on squat and jumping figures at about 8 ± 4.3 weeks (Figs. 2a and 2b).

The Caucasian (Lezginka) style dancer with arthroscopic PCL reconstruction returned to live performance after 21 weeks but he was allowed to perform continuous spinning moves on the flexed knees and Lezginka jump 9 months after the operation (Fig. 3).

Another patient who had to undergo ACL reconstruction and open posterolateral corner (PLC) injury repair due to ACL/PLC injury could perform live 52 weeks later. In Fig. 4, post-operative dancing



Fig. 2 Modern ballet dancer after meniscus repair is (a) squatting and (b) jumping under stress loading.



Fig. 3 Lezginka jumping figure after arthroscopic PCL reconstruction.



Fig 4

Fig. 4 The folk dancer marked with an X in the picture who underwent arthroscopic ACL reconstruction and open PLC repair was on the stage at postoperative 52 weeks. This patient also suffered postoperative arthrofibrosis. The Folk dancer marked with a Y in the picture who had arthroscopic fat pad resection was on the stage at postoperative 19 weeks.

performances of the dancers with ACL reconstruction and PLC repair (*x*) and fat pad resection (*y*) can be seen. All of the operated patients continued with their careers in dancing.

The first patients to return to stage were the ones with scaphoid fracture (6 weeks of injury) and tendon injury (postoperative 8th weeks). Dancers with meniscus injuries returned to stage next (postoperative 8 ± 4.3 weeks). Dancers who had infrapatellar bursa excision, symptomatic plicae excision, patellofemoral ligament repair, fat pad excision returned to stage at 12, 12 ± 5.6 , 16, 18 ± 1.4 weeks consecutively.

The last ones to return to stage were the dancer who had PCL reconstruction (21 weeks) and dancers having ACL reconstructions (40 ± 16.9 weeks).

4. Discussion

Dance injuries are traumatic injuries in 43% and overuse injuries in 57% of the patients [10, 11]. The majority of dance injuries in the literature are overuse injuries (muscle tendon strain, bursitis tendinitis, fasciitis, stress fracture, snapping hip, iliotibial band injury, chondromalacia patella, stress fracture, etc.) of ballet dancers [16]. Overuse injuries are seen in 64% of the female and 50% of the male professional ballet dancers [3, 9, 11, 12]. Traumatic injuries are more prevalent in professional male ballets [11]. In our study male dancers perform more aggressive and ballistic

moves compared to females which we think renders them more susceptible to an injury. The prevalence of injuries that required surgery in our study was 8.6 times higher in males than in females in our cohort study.

The meniscal tears in dancers may vary from partial thickness wear or tear to total avulsion of the meniscus in the joint. Meniscal injuries typically occur following the entrapment of the meniscus between the femoral condyle and the tibial plateau during a turn on a flexed knee. A forceful flexion causes pain in the posterior horn rupture; similarly, a forceful extension causes pain in the anterior horn rupture. Meniscal tears occur from percussive squats or from “screwing the knee” to increase turnout in ballet trainees [17].

In Anatolian folk dances, we suppose meniscal tears occur due to forceful squatting and standing, or turning on a fixed foot. Halay and Horon dances have fast and pounding feet moves [1, 2]. Horon has been shown to be the fastest dance of the world with 218 steps per minute [2]. Unlike the ballet dancers, folk dancers do not tiptoe nor do moves that force the lower extremity to excessive external rotation. Of the Anatolian folk dances, particularly the Roman has frequent moves with external rotation of the hip. Dancers who cannot adequately perform the external rotation try to compensate it by turning their knees, which in turn poses a risk for meniscal tears. Standing on single foot for a long time and turns are basic figures of the Zeybek

dance.

During the performance of these moves, if the dancer cannot turn his/her torso on his/her foot, he/she forces the knee to execute the turn. Such a movement may also result in meniscal tears. The modern dancer performs the squat move as he carries his partner. This move might cause excessive load on the menisci and their entrapment further.

With unfitting shoes or unsuitable floors, the shoe grip of the floor may cause a forceful turn of the knee, thus an injury. In abnormal alignment of the lower extremity, a poor technique and unbalanced flexibility will cause excessive rotation of the knee, which in turn will lead to meniscal tears and ligament sprains [17]. The “swayback” knees (hyperextension of the knee due to excessive ligamentous laxity), particularly in ballet dancers, are usually associated with weak leg muscles and the dancer may become more susceptible to knee injuries [17].

In the literature it is stated that although meniscal tears are common, lateral meniscus damages are more often encountered in dancing when compared to other sports [17]. These tears are rarely acute and are the result of recursive small traumas in the knee. The “overturning” movement of the knee (seen mostly in dancers) combined with the strained iliotibial band is thought to cause degenerative tear by entrapping the lateral meniscus [17]. In our study we only saw medial meniscus tears.

Three of our dancers with meniscal tears had to undergo arthroscopic meniscus repair. All three dancers with meniscal tears were males; two were folk dancers and one was a modern ballet dancer. One of the folk dancers expressed that he had a feeling of locked knee while squatting and standing during the Horon dance and could unlock it by extending his legs and shaking them off. Another folk dancer stated that he felt a sudden pain while turning his body on a single leg. The modern ballet dancer articulated that he felt a sudden pain during the squat move while carrying his partner and the pain prevented him from doing further

squat moves.

Dancer’s injuries which necessitate a surgery in the literature are mostly from the studies on ballet groups [8, 14]. The gender and the dance type have an impact on ACL injuries. Unlike ballet dancers, modern dancers may improvise during the dance and this may increase the risk for ACL injuries. Female modern dance performers are under greater risk of sustaining ACL injuries when compared with their male counterparts and all classical ballet dancers [8].

In our series, three dancers had ACL injuries, all had occurred during the landing sequence after leaping. For a secure landing, the knee is ought to be in flexion and varus position; landing while the knee is in extension and valgus position is a risk factor for ACL injury [14, 18].

Three of our dancers had ACL tears all during the Lezginka figure landing. Of three two were folk dancers and the other was original Caucasian dancer. One of the folk dancers expressed that he heard a loud snapping sound at landing after rotating the knee outward while in excessive hyperextension. The dancer also described excessive hypertension (recurvatum) and inward angulation (varus) of the knee with a sudden swelling. The other folk dancer with ACL injury mentioned about twisting of his knee at landing after leaping and a subsequent swelling. The Caucasian dance performer with ACL injury also stated that his knee had twisted with outward angulation at landing and swollen.

ACL injuries can end the career of a professional dancer [14]. Therefore, the dancer should pay the utmost attention to landing where ACL injuries occur the most. A decent landing, good proprioception and strong muscles are possible with the application of the correct technique. The distance between the two knees should be more than the distance between the two feet during landing. Landing in the varus position with a flexed hip and knee will decrease the risk of ACL injury [14, 18-22].

One Caucasian dance performer in our group

underwent arthroscopic PCL reconstruction with hamstring auto-grafting due to a PCL tear. In most of the Caucasian dance moves, the dancer quickly and recursively lands on his patella with the knee flexed. If the dancer falls on the tibia with his knee flexed, the tibia is pushed toward the posterior of the femur and forces the PCL to tear. In Caucasian dance moves, the dancer jumps on his flexed knee and quickly and recursively turns his body. The PCL tear in our Caucasian dance performed had occurred in such movement. Due to landing on their patella, all Caucasian dance performers use knee braces. If the dancer falls on his flexed knee with a wrong technique, the PCL might be torn.

Patellofemoral dislocation occurs after twisting the knee due to the valgus stress when the foot is on the ground, right before initiating a turn or jump in the air [18]. The required torque is attained by stepping the “standing” foot on the ground; the leg is rotated according to both the foot and the thigh and is angulated. The rotation and angulation of the leg in respect to the foot and hip is increased. Several predisposing factors, including femoral trochlear dysplasia, patella alta, and lateralization of the tibial tuberosity, contribute to patellar instability and lateral patellar dislocation [18]. Environmental factors and unfitting shoes may also cause gripping of the shoe by the ground and thus lead to twisting of the knee and dislocation in turning dance moves.

Knee dislocation may develop without tearing of the medial retinaculum in dancers who have ligamentous laxity [18]. These dancers mention of the “protruding” feeling in their knees, however, there is little or no swelling or tenderness. On the other hand, hemarthrosis and injuries are observed in most dancers with patellar dislocation. The medial retinacular tenderness or the retinacular defect can be palpated in the injured knee. In our series, one female dancer developed patellar dislocation. The dancer described a twist of her knee due to a shoe-grip at the beginning of her spagat move during the karsilama dance, followed

by a severe pain. At her presentation, the patella was dislocated. Reduction was performed under general anesthesia and the repair of the medial patellofemoral ligament was performed consequently. Spagat figure may lead to a patellofemoral dislocation in a patient without any prior patellofemoral problems. This dancer did not have any patellofemoral problems before and her contralateral knee examination was normal.

Our dancers had meniscus tears following frequent squats and twists on single leg stances at Horon and Zeybek dances. On the other hand ACL tears happened after jumps and landings at Caucasian (Lezginka jump) dances. PCL tear was also seen after Caucasian dance landing. Spagat figure in Karsilama dance ended up with a patellofemoral dislocation in one dancer.

The folds formed by the synovial lining in the knee are called plica. The synovial plica in dancers may gain a fibrotic and thicker appearance due to a single trauma or recurring microtraumas (overuse). The thickened plica erodes the lower surface of the patella and the femoral condyles by friction. A fibrotic medial/lateral plica can produce a “click” sound in the location it develops. And tenderness can be palpated in the same region. The knee with the palpable fibrotic plica feels thicker than the contralateral one. [17, 23].

In our series, two dancers with symptomatic plica were performed arthroscopic resection of the plica. Both dancers with symptomatic plicas were folk dancers. The dancers described a pain in the medial patella and over the medial femoral condyle specifically with the movement of the knee. The cases had no obvious history of trauma. The recursive quick and rough knee movements in Anatolian folk dances, especially those in Halay and Horon, may thicken the plicas and make them symptomatic.

Hoffa’s disease is a common disease of the infrapatellar fat pad. The disease is characterized by hypertrophy and fibrosis following inflammation triggered by acute or recurring microtraumas and the impingement of the infrapatellar fat pad between patellofemoral or tibiofemoral joints [24, 25].

The prevalence of the Hoffa's disease in athletes playing basketball, volleyball or performing long jumps is higher [24, 25]. The ligamentous laxity which causes genu recurvatum is a predisposing factor for Hoffa's disease. The disease is more common in young people, specifically in those in their twenties, and is more frequent in females compared to males [24, 25]. In our series, two dancers with Hoffa's fat pad impingement syndrome were performed arthroscopic resection of Hoffa's fat pad. Of these, one patient was male and the other was female. Both were folk dancers and had no obvious history of trauma. With its quick and hard recurring dance moves, Anatolian folk dances may cause Hoffa's fat pad syndrome.

Infrapatellar bursitis is the inflammation of the infrapatellar bursa and manifests itself with anterior knee pain. In our series, resection of the bursa was performed in one dancer with infrapatellar bursitis. This dancer was a male dancer. Many dance moves in this dance group include leaping. We think this is why folk dances may cause the inflammation of the infrapatellar bursa.

Folk dance has been a growing interest in many countries worldwide, yet to our knowledge there are few medical scientific researches in this area. We have observed and treated the worlds' one of the biggest and long performing folk dance groups. Though we have limitations as this study is not with randomized samples. Our sample consisted of one of the most performing and well trained folk dancers which are limited in numbers. We think that further randomized studies should be designed concerning medical problems of folk dancers.

5. Conclusions

Lower extremity and especially the knee region are susceptible to injury in Anatolian folk dancers because of long lasting hard landings and impacts. Certain dance figures seem to be related to specific type of injuries. Our dancers had meniscus tears following frequent squats and twists on single leg stances at

Horon and Zeybek dances. Anterior cruciate tears happened after jumps and landings at Caucasian (Lezginka jump) dances. PCL tear was also seen after Caucasian dance landing. Spagat figure in Karsilama dance ended up with a patellofemoral dislocation in one dancer. Majority (84.7%) of the injuries that required surgery in folk dancers were located in the knee and consisted of ACL/PLC injury, PCL injury, meniscal tear, patellar dislocation, Hoffa's fat pad impingement syndrome, symptomatic plica, and infrapatellar bursitis. Male dancers seem to face greater risk of injuries that require surgery when compared to female dancers. Surgical treatment of these injuries does not necessarily put an end to their dancing career. Folk dance injuries may differ from ballet injuries as our dancers in this study faced more knee but less ankle and hip injuries.

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