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ORIGINAL RESEARCH

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The mid-term effect of Osgood-Schlatter disease on knee function in young players from elite soccer academies

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ABSTRACT

Background: The aim of the study was to evaluate the effect of Osgood-Schlatter disease (OSD) on knee joint function in elite young soccer players. Our hypothesis was that knee joint function in elite young soccer players was impaired following OSD compared with soccer players with no history of OSD.

Method: In young male soccer players (n = 36) from elite academies (mean ±SD, age: age: 15,3 ± 1,7 years; height: 1,7 ± 0,06 m; weight: 63,5 ± 8 kg; BMI: 20,7 ± 2). The duration between the completion of treatment or the last complaint to the study commencement was 31 ± 19 months.

Results: The average treatment duration of OSD among study participants was 18,5 ± 12 days (95%, 14–23), and the disease most often manifested in winter and spring, 33% and 31% of cases, respectively. Soccer players with a history of OSD were statistically different in IKDC and KOOS scores when compared with soccer players with no previously reported OSD (Mann-Whitney, $p < 0,0001$). The soccer players with a history of OSD also use NSAIDs more frequently compared with soccer players with no history of OSD (36% vs 3% respectively).

Conclusions: OSD among young soccer players, when symptoms resolve, continue about one month and they can return to regular training and participation in games. Wherein, the negative effects in knee joint function were significantly more likely in soccer players with previous OSD history when compared with their peers with no history of OSD. While oral non-steroidal anti-inflammatory drugs was also more widely employed in soccer players with previous OSD history. Potentially this may lead to performance deficits and disadvantages for their future careers and coaches and physicians should be informed.

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Osgood-Schlatter disease; tibial tuberosity apophysitis; elite young soccer players; IKDC; KOOS

Introduction

Osgood-Schlatter disease (OSD), or tibial tuberosity traction apophysitis, is most commonly observed in active male athletes aged 12–15 years where frequent accelerations and jumps are prerequisites [1]. There is also a direct relationship between the clinical development of OSD and training load volume [2,3]. Boys are more commonly affected than girls where the average age at symptom onset is 13.7 years [4,5]. Growth spurts and weight gain are also known to occur around this specific age [6]. The prevalence of OSD among physically active adolescents aged 12–15 years is 14%–21% [7–9].

When the key pathogenetic factors in the development of OSD are minor avulsion fractures on the anterior tibial ossification center due to repetitive active knee extension [6,10–12]. Previously documented, a number of predisposing OSD factors have included: (I) regular sports at an adolescent age; (II) short rectus femoris muscle belly; and (III) more proximal and broader tibial attachment of the patellar ligament [4,8,13–15]. The main findings reported following clinical examination are pain and swelling around the tibial tuberosity and worsening when pressure is applied, or exercise is performed [16–18]. In 25–30% of reported cases, symptoms present bilaterally, although unilateral lesions are most common in young 3408 soccer players aged 12–15 years [10,19]. The range in duration of symptoms is 3419 very broad and have been previously documented between 1 and 24 months with self-reduction of symptoms in more than 90% of cases [20–22]. It is important to note that up to 43% of OSD cases can be combined with patellar ligament tendinopathy or bone marrow edema at its distal attachment [14]. A possible explanation for this may be the differing therapy regimens employed and diverse physical activity levels of the subjects [20,21,23]. Evidently, exercise is

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the underlying cause of pain, thus the basis of treatment is often modification of load or complete rest. It has been widely accepted that OSD is a self-limiting disease, i.e. recovery from symptoms generally occurs after the closure of tibial growth plates and therefore, no long-term functional consequences are expected. However, knee joint impairments may still prevail both in patients who underwent treatment for OSD and those who received no therapy [24]. The lack of treatment may cause the long-term existence of symptoms and reduces the quality of daily life [25]. A study by Krause et al. showed that in the absence of treatment, 76% of untreated patients did not experience any restrictions in daily life, but most of them (60%)

99 continued to experience discomfort when in a kneeling position [24]. Similar results were reported by Guldhammer et al. who determined that more than 60% of OSD patients continued to experience pain in everyday life with an average follow-up period of 4 years, and more than half of the patients were forced to limit sports participation [26]. Currently, the existing literature examining the functional capacity outcome of OSD were primarily focused on patients representing the general population, who do not experience maximal mechanical loading on the knee joint, like athletes. Therefore, examining the effects of OSD in an elite young soccer players population would be of practical interest.

In many of studies evaluating soccer players of various levels, age and gender, knee joint function was assessed using the subjective questionnaires International Knee Documentation Committee (IKDC) [27–32].

The Questionnaires Knee Injury and Osteoarthritis Outcome Score (KOOS) has also been used to assess knee function in patients with OSD and in groups of children with overuse knee pain [26,33].

Given that these questionnaires are relatively simple, highly reproducible, and frequently used in sports medicine, they were considered a valid and reliable tool as an assessment of knee joint function in this study.

The aim of the study was to evaluate the effect of Osgood-Schlatter disease (OSD) on knee joint function in elite young soccer players 12 months or more post-treatment. Our hypothesis was that knee joint function in elite young soccer players was impaired following OSD compared with soccer players with no history of OSD.

Materials and methods

Study Design: cross-sectional study

Participants

Our cross-sectional analyzes included young soccer players from four elite soccer

academies with an OSD history (the study group) and young male soccer players

without an OSD history (the control group).

The criteria for elite academies were:

- the presence of the first and highest category according to the classification of the national federation

- the presence of teams of all ages (from 6 to 18 years old)

- the presence of a boarding school for the residence of soccer players from other

regions with a population of at least 40 people

- representation in youth national teams of at least five people.

Data on all the main parameters analyzed in the study were carried out once in June 2021. All players started playing soccer at age 6–7 and were engaged in regular soccer training at least 6–7 times per week when the study recruitment commenced. The study group consisted of soccer players with a history of OSD but continued regular training (n = 36). Additionally, the medical data provided by the team physician was reviewed by two senior independent researchers.

The diagnosis of OSD was based on the history (gradual increase in pain in the area of the tibial tuberosity), complaints (pain that worsens with fast running, squatting, and jumping), and clinical test data (pain on palpation and swelling in the projection of the tibial tuberosity).

X-ray and MRI were used to rule out other possible causes of pain.

Duration of treatment was defined as the period between the onset of complaints preventing participation in training and such a reduction in the severity of OSD symptoms that it allowed training without restrictions in the general group and did not require physiotherapy or any other medical procedures.

Procedures

The inclusion criteria for the study group included: (I) male; (II) history of OSD, but no other diseases or injuries of the knee joint; (III) conservative treatment; and (IV) continued playing soccer after recovering from OSD.

Exclusion criteria were: (I) goalkeeper position; (II) a history of surgical treatment due to any knee joint lesions; (III) terminated career in soccer at study recruitment; and (IV) refusal to participate in the study.

The following variables were evaluated in the study group: time of the year at OSD onset (autumn, winter, spring, summer); initial lesion location (uni- or bi-lateral); and the duration of treatment (in days), the duration between the completion of OSD treatment and the study commencement (months); soccer field surfaces (artificial turf vs. natural grass) which were used for training during OSD.

The frequency of recurrences was also assessed. Recurrences were classified as pain in the tibial tuberosity, which developed within 3 months after the resumption of training and resulted in missing 3 or more training sessions.

The functional state of the knee joint in both groups was assessed using the IKDC and KOOS questionnaires. Following a thorough explanation by the team doctor, each participant completed the questionnaires.

Regarding frequency of NSAIDs, participants selected from five options:

(I) no use;

(II) very rare use: less than once in 3 months;

(III) rare use: more than once in 3 months, but less than once in a month;

(IV) regular use: more than once in a month;

(V) frequent use: twice and more in a month.

During treatment periods players refrained from their normal training activities and performed a modified version. The treatment protocol consisted of conservative measures, where no player received surgery. Conservative treatment without immobilization was applied to all patients. This included kinesiotherapy for quadricep muscle lengthening and a gradual increase in physical activity.

Surgical treatment or complete avoidance of exercise was not conducted with any patient. After the initial treatment period, a gradual return to regular training was implemented. In all cases, a previously documented protocol was employed that included physiotherapy for symptom control, exercise avoidance, and quadricep stretching [23] where kinesiotherapy was the main treatment method.

This included exercises for stretching the quadricep femoris muscle. During the sports avoidance period, exercise was performed four times a week and comprised of three sets of 10 to 12 repetitions. Following the resumption of sporting activities, exercise was performed three times a week, comprising of two sets of 10 to 12 repetitions prior to the match-play.

Physiotherapy was also employed to improve OSD symptoms. Players received 10 magnet field therapy sessions, each lasting 20 minutes. Players also received five to seven sessions per week of transcutaneous calcium chloride applications in front of the tibial tuberosity, for 30 minutes each, as well as local cryotherapy utilizing the GameReady® cold and compression device for 15 minutes following rehabilitative exercise.

Ethical Approval

All procedures involving human participants were conducted in accordance with the 1964 Helsinki declaration. Written informed consent was obtained from all participants parent or legal guardian and to ensure confidentiality, all data were anonymized before analysis.

Results

The study group consisted of male young outfield soccer players (n = 36) with

a history of OSD, but without other knee joint conditions (mean ± SD, age: 15,3 ± 1,7 years; height 1,7 ± 0,06 m; weight 63,5 ± 8 kg; BMI: 20,7 ± 2).

The control group consisted of male young outfield soccer players (n = 36) without OSD and other diseases and knee joint injuries in anamnesis (mean ± SD, age: 14,9 ± 1,8 years; height: 1,7 ± 0,08 m; weight: 62,4 ± 9 kg; BMI: 20,6 ± 2). The study and control groups did not significantly differ in age, height, weight, and BMI.

The average time between the completion of OSD treatment episode prior to the start of the study was 31 ± 19 months.

The onset of OSD occurred most frequently in players aged 12,9 ± 1,2 years.

Average treatment duration was 18,5 ± 12 days (95%, 14–23). Osgood-Schlatter disease was most commonly observed in winter (December to February) 33% (n = 12), spring (March to May) 31% (n = 11), summer (June to August) 22% (n = 8), and autumn (September to November) 14% (n = 5). Unilateral lesions were observed in 97% (n = 35) of participants while bilateral lesions were only evident in 3% (n = 1) of participants. Recurrences were observed in 19% (n = 7) of soccer players where the average treatment duration for a recurrence was 40 ± 37 days. Players that developed OSD were training on artificial turf more commonly (75%, n = 27) than natural turf.

The study and control groups differed significantly in IKDC scores where the control group had higher scores (89,75 ± 11,09 and 99,26 ± 1,66, respectively Mann–Whitney, $p < 0,0001$).

The KOOS were also higher in the control group compared to the study group across all variables (Table 1) and this was statistically significant (Mann–Whitney test)

Results in control group were higher than in the study group and the difference between them was statistically significant according to the Mann-Whitney test for all five subscales: symptoms ($p = 0,004$), pain ($p = 0,001$), activities of daily living function ($p < 0,0001$), sport and recreational function ($p < 0,0001$), quality of life ($p = 0,001$).

The use of NSAIDs was significantly different between the study and control groups (Mann-Whitney, $p < 0,0001$). The use of NSAIDs was more prevalent in the study group compared to the control group (36% and 3% respectively). The rare use of NSAIDs (22% of cases, n = 8), regular use (6% of cases, n = 2), and frequent use (8% of cases, n = 3) were observed. However, NSAIDs use was only observed in 3% of cases (n = 1) in the control group. In the study group, scores on all subscales did not differ in athletes with different frequencies of NSAIDs use.

Anthropometric parameters did not correlate with KOOS or IKDC scores (Spearman's rank correlation coefficient). Anthropometric parameters were also not associated with NSAIDs use in the study group.

Discussion

Our findings indicate that although young soccer players recovered from OSD and resumed regular training and

Table 1. KOOS in the control and in the study groups.

	Control group					Study group				
KOOS scores	Symptoms	Pain	Activities of daily living functions	Sport and recreation function	Quality of life	Symptoms	Pain	Activities of daily living functions	Sport and recreation function	Quality of life
Minimum	89,2	94,4	97,0	85,0	75,0	72,0	88,8	89,7	40,0	25,0
Maximum	100	100	100	100	100	100	100	100	100	100
Average	97,3	99,5	99,8	98,3	98,4	92,5	97,1	98,0	88,3	92,4
Standard deviation	3,5	1,6	0,6	3,8	5,5	7,5	3,9	3,1	14,8	16,2

competitive activity, they may have functional knee joint impairments and use NSAIDs more frequently than their peers post completion of OSD treatment. However, these players may return to professional-level soccer training despite impaired knee joint function, which supports previous research findings [23].

Notably, in 97% of our cases the presentation of OSD was unilateral, which differs from previous works [23]. Bezuglov et al. showed that bilateral symptoms were observed in almost 43% of cases [23]. This disparity may be explained by the fact that we evaluated the presentation of initial lesion, while Bezuglov et al. evaluated the presence of symptoms during the course of OSD. However, this finding needs further examination, as patients who actually present bilateral OSD may only report pain in one knee and not report pain on the other side. The prevalence we found is comparable to previous data from other researchers [34]. It should be remembered that another common cause of anterior knee pain can be patellar tendinopathy (jumper's knee) [35]. Both diseases have similar development mechanisms, risk factors and principles of treatment and can occur in soccer players [36]. However, the treatment of jumper's knee may take longer and if an inappropriate treatment protocol is selected, the disease may become chronic [37]. Therefore, practitioners should be mindful of the similarities during these two different pathologies and strive for the fastest possible diagnosis using tendon imaging techniques (ultrasound and MRI) [38–40].

The study also revealed a more frequent occurrence of OSD in winter and spring, which may be associated with a high risk of developing vitamin D deficiency during this period, the synthesis of which largely depends on the duration of insolation and the activity of ultraviolet rays. An association between the development of OSD and vitamin D deficiency was demonstrated earlier in a study by Smida et al., with soccer players from Tunisia [41].

The functional state of the knee joint is extremely important for soccer players. Some injuries to the knee joint may affect performance and even career length.

During this study young soccer players who recovered from OSD reported lower IKDC and KOOS scores and were more likely to use NSAIDs. Despite the fact that in our work we have shown that players who suffered with OSD continued to play soccer at a professional level, it is not clear whether the symptoms affected the level of them performance.

Our findings question the broadly accepted concept that OSD is a self-limiting disease. Rathleff et al. highlighted those adolescents between 10 and 14 years old with OSD reported 22 to 56 points lower ($p < 0.001$) in the KOOS scores compared with the control group, while noting the lowest score on the 'sport and recreation' and 'quality of life' sub-scale [42]. Furthermore, Holden et al. found that there is growing evidence that OSD might have long-term consequences [43]. Our results support the findings of Guldhammer et al. who analyzed the long-term effects of OSD in recreational adolescent athletes. It was shown that the majority of adolescent athletes had marked knee joint function impairments, assessed with the KOOS scale, 4 years after recovering from OSD [26]. In this study, 60,5% of patients reported OSD-related knee pain (median follow-up was 3,75 years) and those with knee pain had lower KOOS scores. Earlier studies examining the natural history of untreated OSD highlighted that limitations in activity might persist for 30 years or more after recovery [24]. Therefore, OSD may initiate knee pain for many years after diagnosis, which may also cause a substantial decrease in sporting performance or general life.

However, the data on the influence of OSD history on the health of professional soccer players are still scarce and further research is needed. It has been well documented, that NSAIDs pose substantial risks to professional athletes, including delayed bone healing, decreased protein synthesis, and even gastric bleeding [44,45]. However, NSAIDs are still widely used in professional sports [44]. Many athletes use NSAIDs early in their career. Warner et al. stated that one in seven American soccer players used NSAIDs daily [30,46], which can lead to side effects with chronic use, including gastrointestinal, nephrotoxic, and serious cardiovascular consequences [45]. In our study, the prevalence of NSAIDs usage in the study group was 36%, which is significantly higher when compared to the control, but less when compared to research into student American soccer players (75% in young athletes (mean age 15,8 years) [46]. In comparison, the prevalence of NSAIDs usage in our study was only 3% in the control group. Currently, there are no studies available examining NSAIDs usage in elite young soccer players, and thus, it would be interesting to explore these results in future studies.

Our study identified several limitations including a relatively short observation period and no objective measure of knee joint functionality. Utilizing various instrumental diagnostic methods, a more thorough and detailed examination into the underlying cause limiting knee joint function would be worthwhile. In addition, it would be interesting to compare physical and technical performance variables in recovering soccer players and players with no history of OSD.

Future research should focus on the impact of impaired knee joint function on performance, sports-specific physical activity, and motion parameters, as well as determining the factors causing long-term impairments. The usage of NSAIDs in elite young soccer players should also be examined in detail, as it poses potential health risks.

Conclusion

OSD among young soccer players becomes quite quickly and they can return to regular training and participation in games. However, the long-term negative effects in knee joint function were significantly more likely in soccer players with previous OSD history when compared with their peers with no history of OSD.

Oral non-steroidal anti-inflammatory drugs were also more widely employed in soccer players with previous OSD history. This may lead to the development of potentially dangerous health conditions, including gastric ulcers and changes in the rheological properties of the blood. Coaches and physicians should be aware of this possibility.

Ethical statement

The study was approved by the local Ethics Committee. All procedures performed involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments. All participants' parent or legal guardian gave their written consent to the collection and processing of data, which were completely anonymous.

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