Musculoskelet Surg (2017) 101:195–200
DOI 10.1007/s12306-017-0479-7

REVIEW

Treatment of Osgood–Schlatter disease: review of the literature

E. Circi[1] · Y. Atalay[2] · T. Beyzadeoglu[3,4]

Received: 15 November 2016 / Accepted: 31 May 2017 / Published online: 7 June 2017
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Abstract
Background Osgood–Schlatter disease (OSD) is a self-limiting condition which occurs commonly in adolescence.
Purpose The objective of this article is to review published literature regarding pathophysiology, diagnosis and treatment of OSD.
Methods A search of the literature was performed on the electronic databases PubMed, Cochrane and SCOPUS databases between 1962 and 2016 for pathophysiology, diagnosis and treatment of Osgood–Schlatter disease.
Results OSD, also known as apophysitis of the tibial tubercle, is a common disease with most cases resolving spontaneously with skeletal maturity. In pathophysiology, the most accepted theory is repetitive knee extensor mechanism contraction. The pain is localized to the anterior aspect of the proximal tibia over the tibial tuberosity. They may describe a dull ache exacerbated by jumping or stair climbing. Radiological evaluation may indicate superficial ossicle in the patellar tendon. Osgood–Schlatter is a self-limited disease and generally ceases with skeletal maturity. Treatment is usually symptomatic. Adults with continued symptoms may need surgical treatment if they fail to respond to conservative treatment. Surgical procedures include open, bursoscopic and arthroscopic technique. Arthroscopic surgery is beneficial over an open procedure due to early postoperative recovery, no incisional scar in front of the tuberosity that usually causes discomfort in kneeling with a better cosmetic result and the ability to address concomitant intra-articular pathology.
Conclusion Osgood–Schlatter syndrome runs a self-limiting course, and usually complete recovery is expected with closure of the tibial growth plate. Overall prognosis for Osgood–Schlatter syndrome is good, except for some discomfort in kneeling and activity restriction in a few cases. Arthroscopic techniques seem to be the best choice of treatment of unresolved Osgood–Schlatter lesions.

Keywords Osgood–Schlatter disease · Pathophysiology · Diagnosis · Treatment surgery · Review

Introduction

Osteochondrosis of the tibial tubercle was first documented in the early 1900s. Two different physicians reported on an experience in which active adolescents were complaining of pains centered on the tibial tubercle while engaging in activities involving jumping and running. Both Osgood and Schlatter were recognized with identifying this condition and thus attached to its title. They explained the process as occurring in children who are undergoing rapid growth and who place stress on the developing tubercle through patellar tendon force. The researchers distinguished this condition from a tibial tubercle avulsion fracture and stressed that the condition is due to repetitive loading of the area [1]. Osgood–Schlatter disease (OSD) is a traction

✉ T. Beyzadeoglu
tbeyzade@superonline.com

[1] Department of Orthopaedics and Traumatology, Istanbul Education and Research Hospital, Istanbul, Turkey

[2] Department of Orthopaedics and Traumatology, Sisli Hamidiye Etfal Education and Research Hospital, Istanbul, Turkey

[3] Department of Orthopaedics and Traumatology, Beyzadeoglu Clinic, Bagdat Cad. Cubukcu Apt. No:333/8, 34738 Erenkoy, Istanbul, Turkey

[4] Department of Physiotherapy and Rehabilitation, School of Health Sciences, Halic University, Istanbul, Turkey

apophysitis of the tibial tuberosity caused by the repetitive strain on the quadriceps femoris muscle. The primary cause of this condition is the stress from the patellar tendon at its point of insertion [2, 3]. In a recent study, the shortening of the rectus femoris muscle was also reported to be one of the main factors associated with the presence of OSD in adolescents. The injury mechanism in adults is usually related to the direct impact on the tubercle, rather than contraction of the quadriceps as seen in adolescents [4].

Etiology

In pathophysiology of disease, there is a partial loss of continuity of the patellar tendon-cartilage-bone junction of the tibial tuberosity. An inflammatory process starts in the region and ends with patellar tendinitis, multiple subacute fractures, irregular ossification with underlying bone. The most accepted theory of this condition is repetitive knee extensor mechanism contraction. As a result of these contractions, avulsions or microavulsions occur at the chondro-fibro-osseous tibial tuberosity. If patients who have injured the tibial tubercle continue sport activities, microavulsions increase over time. This may cause a separated fragment of the patellar tendon leading to a chronic, nonunion type of pain [5–7]. However, some of the radiological studies showed that patients affected by OSD have anatomical differences at the point of insertion of the patellar tendon. Besides, histological studies support traumatic etiology, showing no inflammation [8, 9].

Epidemiology

OSD was originally reported to occur more frequently in boys than in girls. With the increasing number of young female athletes, this disease is now being seen at a similar rate to young males. There are a few recent studies that show no significant difference in the prevalence of the disease between males and the females [4]. OSD is typically more common between the ages of 8–13 years in girls and between 12 and 15 years in boys [5]. OSD affects 21% of athletic adolescents, while it is seen in 4.5% of age-matched nonathletic controls [10, 11]. The disease is bilateral in 20–30% of patients [4].

Clinical findings and physical examination

The individual's history and the physical examination are usually sufficient to make a diagnosis of OSD. Patients complain of activity-related pain focused over the tibial tubercle and distal patellar tendon. The pain, occurring with activities and subsiding with resting, is the presenting symptom. There is a trauma history behind this situation which occurs during sporting activities such as basketball, volleyball, gymnastics and soccer. There is pain during activities like running and jumping which loads the knee in flexion, leading to an eccentric quadriceps contraction [5].

Tenderness, swelling, thickening of the patellar tendon and enlargement of the tibial tuberosity are often observed during physical examination. Patients may walk with an antalgic gait. During palpation, a firm mass (bone irregularities) is often observed in chronic conditions. Acute cases may present with an extensor lag. There is no sign of effusion or instability, and passive range of motion in the knee is full. The frequency of quadriceps and hamstring muscle tightness is common [5, 12].

The differential diagnosis of OSD includes osteochondritis dissecans, Sinding-Larsen–Johansson syndrome, patella-femoral syndrome, patellar dislocation or subluxation, chondromalacia patellae, avulsion fracture of the tibial tuberosity, pes anserinus bursitis, tumor and infection. If the pain is worse at night or during rest, a differential diagnosis should be considered. They should be accreted with a detailed history, focused physical examination and radiography of the patient [13, 14].

Radiological findings

Plain radiographs are ordered for the evaluation of the tibial tuberosity. The lateral radiograph is most helpful in evaluating the extensor mechanism (Fig. 1). Radiological evaluation may indicate superficial ossicle in the patellar tendon, soft tissue swelling anterior to the tibial tuberosity and thickening of ligamentum patellae. These may be a normal variant in asymptomatic children, especially in the preossification phase. On the other hand, there have been cases reported as diagnosed with radiography without any symptoms. A sequel of OSD like an ossicle in the patellar tendon, which is rarely observed, may be present with an acute knee pain and could be considered as a fracture at first. A fragmentation of apophysis shows that the patient is in the chronic stage.

Ultrasound (US), magnetic resonance imaging (MRI) and computerized tomography (CT) are other imaging modalities used for the diagnosis of OSD. US may show the thickened patellar tendon better than plain radiography. It can also demonstrate pretibial swelling, fragmentation of the ossification center and excessive fluid collection in the infrapatellar bursa [15]. In MRI, T2-weighted imaging, increased hyperintense irregular signal intensity superior to epiphyseal line in the proximal part of the tibia can be viewed. Also, MRI may be more useful for revealing early and progressive lesions or atypical presentations of OSD

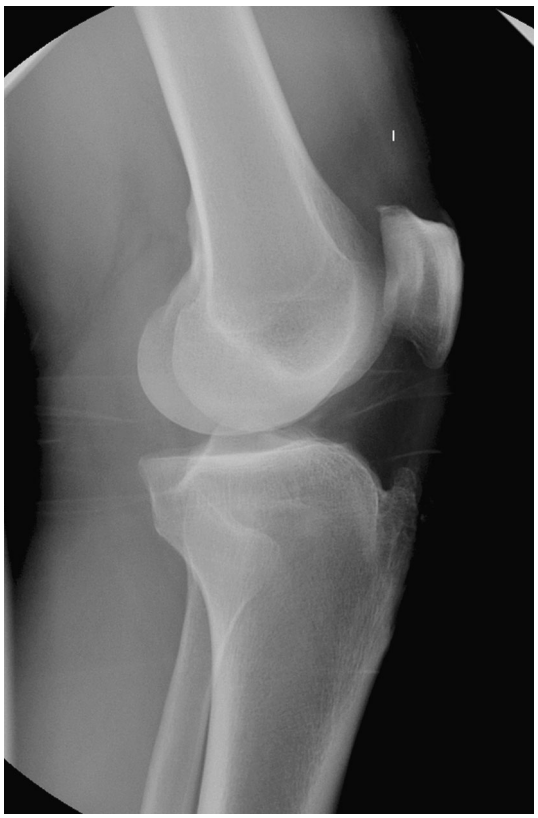


Fig. 1 Bony prominence over the tibial tuberosity at lateral knee X-ray as a sequele of OSD

[3]. It may play a role in the future in the staging of the disease and prognosticating the clinical course, as the role of MRI in diagnosis, prognostication and management is currently limited [5].

Treatment

Conservative treatment

The treatment of OSD is guided by the severity of the symptoms. OSD is a self-limited disease and generally ceases with skeletal maturity. Improvement can be gradual. The condition may recur for 12–18 months before complete resolution at skeletal maturity. This correlates with the closure of the apophysis. Although most patients continue with active involvement in sports, the severity of pain in some individuals leads to change in sports or in position. Non-impact activities, including swimming and cycling, can be implemented to maintain patient's cardiovascular fitness. Hamstrings and quadriceps flexibility exercises will maintain knee range of motion and may accelerate recovery.

Conservative therapy includes the restriction of or adjustment to pain-producing activities, proper padding of the tibial tubercle until the symptom resolves. This may consist of a brief period of controlled immobilization for those unable to perform their activities of daily living. OSD may cause knee joint disability in the chronic stage. According to a study, such patients with recurring symptoms should be regularly followed with clinical and radiological evaluations during conservative treatment [12]. Complications like pseudo-arthrosis, genu recurvatum, patella alta, fragmentation/migration of the ossicle may occur leading to early osteoarthritis [16]. Up to 10% of patients experience persistent symptoms into adulthood, despite conservative measures [11].

Medication

For the medication of OSD, nonsteroidal anti-inflammatory drugs are generally used in a short period of time. They are given for pain relief and reduction of local inflammation. In particular, ibuprofen, naproxen, flurbiprofen and ketoprofen, which decrease prostaglandin synthesis and have analgesic, antipyretic and anti-inflammatory effects, are chosen.

Injection

In the past, some authors recommended an injection of corticosteroids into patellar tendon to provide symptomatic relief. However, it is not recommended currently due to its deleterious effect. It can cause subcutaneous atrophy and rupture of the patellar tendon [17, 18]. In 2011, a study on hyperosmolar dextrose injection for the recalcitrant OSD was made in adolescent athletes. In the study, the potential of 12.5% dextrose injection versus 1% lidocaine injection versus supervised usual care to reduce sport alteration and sport-related symptoms was examined in patients. Topol et al. [19] suggested that both the duration of sports limitation and the duration of sports-related symptoms could be reducible by dextrose injection than either lidocaine injection or usual care in those with recalcitrant OSD.

Surgical treatment

Although conservative management has been conventionally favored [20], for patients who have intolerable symptoms, surgical intervention can be successful [21–23]. Surgery is rarely indicated for OSD in adolescents. Researchers revealed that the removal of ossicle fragmentation in immature patients leads to premature fusion of the tibial tubercle [24]. Particularly, adults with continued symptoms may need surgical treatment and there have been some studies on it [17]. Surgical procedures include drilling of the tubercle, removal of the loose fragments, autogenous bone peg insertion through the tubercle, tibial tuberosity excision or sequestrectomy. Surgical management of the OSD can be

approached by open [21, 22, 25] or arthroscopic [26, 27] or direct bursoscopic excision [28].

Open procedures

The two most common procedures performed are ossicle excision and tibial tubercle prominence resection [21, 23]. Ossicle removal is supposed to be the best method in the surgical treatment of OSD [23, 26]. Tubercle prominence resection has also shown good results in recalcitrant cases [25, 29].

Procedures that promote early fusion of the apophysis of the tuberosity to the diaphysis, such as pegging the tubercle to the tibial metaphysis with autogenous bone graft or drilling the tuberosity, have not been recommended. Premature fusion of the anterior part of the epiphysis leading to genu recurvatum has been reported [30, 31].

In 1980, Mital described unresolved Osgood–Schlatter lesion as a condition that does not resolve spontaneously and responds to nonoperative measures. Surgical treatment was recommended for unresolved OSD [23].

In a review of the surgical treatment of unresolved Osgood–Schlatter syndrome in 2009, Pihlamajaki et al. concluded that in younger adults, good to excellent functional outcomes can be achieved with open surgical treatment. In the study, 87% of patients reported that they could participate without restriction in daily and work activities. In total, 75% of patients regained their preoperative sports activity level. In total, 38% reported the ability to kneel without pain [32].

In 2010, El Husseini et al. reported a study on the results of surgical treatment of OSD in adults. In total, 91% of patients had complete resolution of preoperative pain. They used an incision over the anterolateral aspect of the patellar tendon. The patellar tendon was reflected medially, and the ossicle was removed from the posterior surface of the tendon. This surgical technique for the treatment of unresolved OSD was told to be safe and effective in adults [33].

Nierenberg et al. reported their experience with 22 OSD patients who were refractory to conservative treatment modalities, with clinically evident mobile ossicles and radiological confirmation of the presence of a free osseous fragment. The study evaluated the patients after 1 year of follow-up. Based on their experience, they devised a treatment algorithm. Most patients were operated under local anesthesia. A midline longitudinal skin incision was used, followed by subperiosteal dissection of the osseous fragment. The knee was put in soft dressing. Patients were encouraged to resume daily activity immediately postoperatively. Twenty patients reported subjective satisfaction with the surgery.

All patients returned to their previous level of physical activity within 12 weeks postoperatively. Their results were uniformly good; the only failure was related to mistaken inclusion criteria where the lateral radiograph did not show clear ossicle separation. They claimed that the key factors for successful surgical treatment were clear visualization of separation at lateral knee radiographic view and a clinical mobility positive test (firm grasping of the prominent part of the tubercle and its sliding movement) [34].

Arthroscopic and bursoscopic procedures

Arthroscopic techniques for surgical treatment of recalcitrant OSD have also been recommended in recent years. It is a less invasive surgical modality for most of the intra-articular procedure. It is said to be beneficial over an open procedure because the patellar tendon is not violated. Other intra-articular knee pathologies can also be diagnosed arthroscopically. The patient avoids an incision directly over the patellar tendon that can cause pain with kneeling [27].

DeBerardino et al. recommended an arthroscopic technique with recalcitrant OSD lesions. They revealed two patients with excellent short-term results [27]. The location of the infero-medial and lateral para-patellar tendon portals was raised slightly to allow improved instrumentation and visualization in the anterior interval. An anterior interval release was performed with the mechanical shaver and radiofrequency ablation device. Care was taken to visualize the meniscal anterior horns and inter-meniscal ligament. By staying anterior to these structures, debridement was performed aggressively onto the anterior tibial slope. The bony lesions were shelled out from their soft tissue attachments. Small and loose fragments were removed with a pituitary rongeur, whereas larger lesions were removed with an arthroscopic burr. Working deep along the anterior tibial slope was facilitated by extending the knee and taking tension off the patellar tendon. Postoperatively, patients were allowed full weight bearing and unrestricted range of motion. They reported complete resolution of patients' symptoms and recommended their arthroscopic technique. The advantages of this technique were less damage to the patellar tendon, early postoperative recovery, no incisional scar in front of the tuberosity that caused discomfort in kneeling with a better cosmetic result and the ability to address concomitant intra-articular pathology [5].

The senior author has published a case report of arthroscopic excision of an ununited ossicle due to OSD in a 24-year-old soccer player with recalcitrant symptoms of OSD, in 2008. Arthroscopy was performed through the standard low anterolateral and anteromedial portals close to the patellar tendon. The ossicle was separated from the surrounding soft tissue with a motorized shaver and radiofrequency device and removed by use of a grasper. After excision of the ossicle, the inflamed surface of the

retro-patellar tendon was also debrided. The contouring of the irregular surface of the tibial tubercle was performed by use of a motorized bur. Fluoroscopic control was performed after excision of the ossicle. The patient's extremity was placed in a soft tissue dressing after the completion of the procedure, without any immobilization, and he was discharged on the same day. After 6 weeks, the patient returned to sports activities without any restrictions. This study also confirmed that all of the described procedures could be done arthroscopically and sporting activities may be allowed earlier [26].

Recently, bursoscopic excision technique has been introduced. Eun et al. described low anterolateral (L-AL) and low anteromedial (L-AM) portals separately to perform ossicle excision. They created a soft tissue tunnel using a straight mosquito clamp into the bursa space. The arthroscope was introduced through the L-AL portal, while a motorized shaver was inserted through the L-AM portal. Eun et al. [28] revealed that bursoscopic ossicle excision accompanies satisfactory results in selective young and active patient with persistent symptoms. However, in the arthroscopic surgery, the intra-articular portion of the infrapatellar fat pad can be violated during the resection of the ossicle [26, 27]. Eun et al. suggested that bursoscopic approach may be more suitable for unresolved OSD to minimize infrapatellar fat pad violation. They also publicized that bursoscopic surgery shows limitation in reducing the prominence of the tibial tuberosity [28]. We summarized a treatment algorithm in Fig. 2.

Physiotherapy and rehabilitation

Rehabilitation following surgical procedures includes the placement of a hingled knee brace locked in extension and full weight bearing. Early passive knee range of motion is allowed. Weight bearing in extension is mandatory for the first 3–4 weeks if tendon healing to bone is needed. Motion of the knee should be limited if there is any concern that the bone-tendon unit is at risk. Straight-leg raises can be initiated immediately after surgery. Once tendon healing is complete, usually between 4 and 6 weeks, active range of motion and strengthening are allowed [35].

Summary

OSD is a self-limiting condition which occurs commonly in adolescence. Patients who have a history of a rapid spurt of growth and participate in intense sports in their early age present with anterior knee pain during activities. Although the conservative treatments are efficient in the acute stage, symptoms may continue in severe cases. It may affect patients' daily activity and reduce performance in sports.

There has been a reported successful experience about surgical treatment of unresolved OSD patients. Surgical procedures include drilling of the tubercle, removal of the loose fragments, autogenous bone peg insertion through the tubercle, tibial tuberosity excision and sequestrectomy. Cosmetic discomfort, late postoperative recovery and

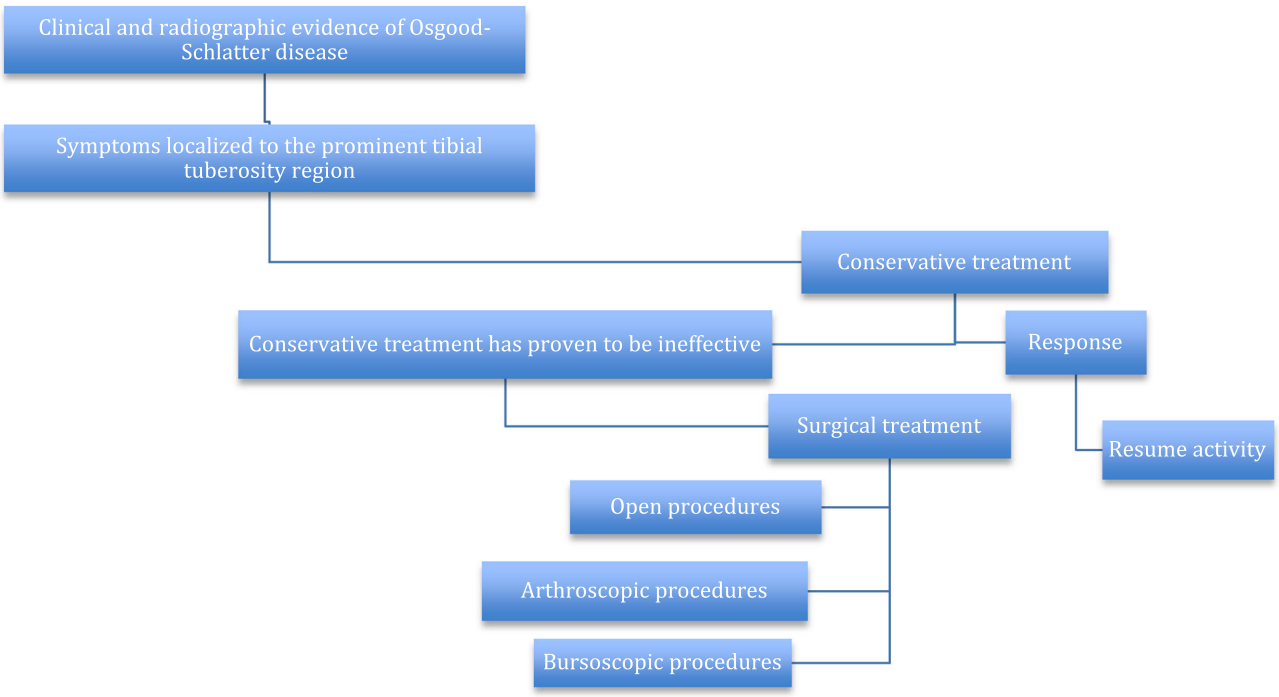


Fig. 2 Treatment algorithm

longer period to return the activity occur after open surgery. Bursoscopic technique also described alternatively the other procedures, but this technique showed limitation in reducing the prominence of the tibial tuberosity. It is said to be beneficial arthroscopic surgery over an open procedure because the patellar tendon is not violated and intra-articular knee pathologies can also be diagnosed. Thus, arthroscopic techniques might be the most appropriate treatment of unresolved Osgood–Schlatter lesions.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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