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Review article

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Invasive treatments for Osgood-Schlatter disease (systematic literature review)

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Abstract

Introduction Osgood-Schlatter disease is manifested by pain, swelling and the appearance of a painful "bump" in the area of the tibial tuberosity. For 90 % of patients, conservative treatment is effective. It relieves painful symptoms but if they persist after the closure of the growth plate, surgical treatment is recommended. The study of literature reviews on invasive methods of treatment of the Osgood-Schlatter disease revealed only a few works on various methods of treatment with a description of clinical cases. **Purpose** Review of current methods of invasive treatment of Osgood-Schlatter disease, comparison of their effectiveness from the point of current evidence-based requirements. **Materials and methods** The electronic databases eLibrary, PubMed and Scopus were used for literature search. **Results** This literature review presents a comparative analysis of the effectiveness of various surgical methods of treatment, namely, the use of surgical and puncture methods. The main advantages of the methods were discussed, as well as their disadvantages caused by postoperative complications or difficulties resulting from the techniques for their implementation. Conservative treatment, which is resorted to in the majority of cases, does not relieve pain in the knee joint, and discomfort at sport activities persists. Minimally invasive techniques, which were used by a number of authors whose works are described in this review, are at a low level in the hierarchy of evidence, because there no large comparative studies. **Conclusions** Due to the rarity of surgical treatment of this pathology, it makes sense to create a register of patients with Osgood-Schlatter disease for the purpose of a remote unified assessment of treatment results in order to identify the most appropriate method of surgical intervention.

Keywords: Osgood-Schlatter disease, aseptic necrosis of the tibial tubercle (TT), tibial tubercle apophysitis, invasive treatment of OS disease, surgical methods of OS disease, arthroscopy, plasma therapy, PRP therapy

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INTRODUCTION

Inflammation of the apophysis at the site of patellar ligament attachment to the tibial tuberosity was first described in 1903 by Osgood and Schlatter independently [1]. The causes of the disease are the tension of the anterior group of thigh muscles, the patellar ligament and microtrauma in this area, which cause rupture of microvessels and lead to inflammation of the tuberosity area, the ossification nucleus, and fractures of the tibial tuberosity. Most often, this pathology occurs in male patients aged 10 to 14 years who are actively involved in sports (sprinting, jumping, etc.). Osgood-Schlatter disease (OSD) is clinically manifested by pain in the area of the tibial tuberosity, swelling and the appearance of a painful "bump" in this area [2]. Effective measures of conservative treatment include activity restriction and lifestyle modification, orthotics, prescription of NSAIDs, local hypothermia, temporary refusal to play sports, physiotherapy, as well as exercises aimed at stretching the quadriceps [3]. In addition, shock wave therapy can be considered a separate method of physiotherapy [4]. For 90 % of patients, conservative treatment is effective and relieves painful symptoms; however, if they persist after growth plate closure, surgical treatment is recommended [5].

In 2020, C. Neuhaus et al. summarized the methods, experience of conservative treatment and rehabilitation after OSD in their review [3]. At present, there are no reviews systematizing the methods of surgical and invasive treatment of OSD. There are single general reviews on treatment methods that accompany the description of clinical cases [6, 7]. According to the PROSPERO database (https://www.crd.york.ac.uk/prospero/), there are currently no systematic reviews on the topic of surgical and invasive treatment of OSD.

The **purpose** of this study is to review the current methods of invasive treatment of Osgood-Schlatter disease, comparing their effectiveness from the viewpoint of current evidence-based requirements.

MATERIALS AND METHODS

A systematic review of invasive OSD treatment methods was carried out using the recommendations of the PRISMA protocol (2020) [8]. Inclusion criteria were studies with clinical data and full text in English, German and Russian, available on the Internet for the maximum possible period of time. Inclusion criteria were original studies of varying evidence levels: clinical cases and series of clinical cases, cohort and

randomized studies. Exclusion criteria are literature reviews, editorial opinions, revisions.

Search Keywords: Osgood, Schlatter, Osgood`s, Schlatter`s, surgical treatment, surgical procedures, operative treatment, invasive treatment, surgical treatment, invasive treatment, Osgood-Schlatter (Schlatter) disease. Information was searched using the PubMed, Scopus, eLibrary databases from December 1, 2021 to April 1, 2022. No contact was made with the authors of the included papers to obtain additional data. For data collection from PubMed (https://pubmed.ncbi.nlm.nih.gov/advanced/) and Scopus (https://www.scopus.com/search/form.uri?display=advanced), advanced) search query; eLibrary (https://elibrary.ru/querybox.asp) is a standard search query form. Search queries and their results are shown in Table 1.

Search query data was exported using the built-in PubMed, Scopus and eLibrary database functionality to the Mendeley software for further analysis. Reference lists were also extracted from literature reviews encountered in the search process and, in the absence of these works in the final stage of the analysis, they were added (works from other sources).

Removal of duplicates

The collected data, including titles and abstracts, were imported into the dedicated Rayyan web application (https://rayyan.ai) for systematic review by the research team. Using the de-duplication function of the Rayyan web application, followed by manual control, the final removal of duplicates by one researcher was performed. Thus, 294 original articles were identified, which moved to the next stage.

Screening

Next, the titles and abstracts of all publications were analyzed independently by two researchers [DA] and [MP]. Each work was assigned with "include", "exclude", "maybe". In disputable situations, a third researcher [FL] was involved to resolve conflicts. According to the inclusion criteria, on the basis of the title and abstracts of the articles, papers were selected for full text analysis (2 stages of screening). From the remaining publications, the works were selected based on the analysis of the full text of the publication according to the inclusion criteria, using a similar methodology (Fig. 1).

Table 1

Search queries and results

Databases	Search enquiry	Number of publications
PubMed	"osgood" OR "osgood s" AND "schlatter" OR "schlatter s" AND ("surgical procedures, operative"[MeSH Terms] OR ("surgical" AND "procedures" AND "operative") OR "operative surgical procedures" OR ("surgical" AND "treatment") OR "surgical treatment" OR "invasive treatment")	86
Scopus	("Osgood Schlatter`s"OR"Osgood Schlatter")AND("surgical procedures, operative"OR("surgical"AND"procedures"AND"operative")OR"operative surgical procedures"OR("surgical"AND"treatment")OR"surgical treatment"OR"invasive treatment")	350
eLibrary	«Болезнь Осгуда-Шлаттера, хирургическое лечение», «Болезнь Осгуда-Шляттера, инвазивное лечение»	38

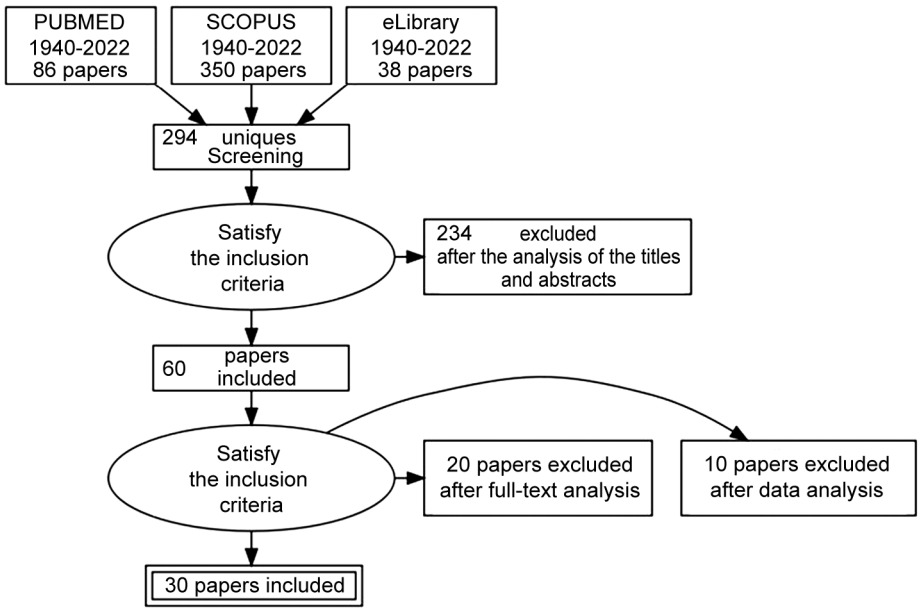

Fig. 1 Diagram of selection of available studies

Analysis

All selected publications were introduced into a Microsoft Excel database table. An assessment was made for the level of reliability (Table 2). Attention was drawn to the methods of invasive and surgical treatment, indications and contraindications for various methods, results and prognosis of treatment. The data were introduced by one researcher [DA], two other researchers independently checked the accuracy of the entered data [MP] and [FL]. If the filled information was incorrect, the correction was carried out. If the interpretation of the data from the publication was ambiguous, the decision on whether to enter the information was made collectively after discussion.

Statistics

At each stage of the screening, a statistical check of the Coenn Kappa fit was conducted.

Table 2

Studies included in the review

Authors	Year of publication	Level of evidence	Number of patients	Study type
Mital M.A.	1980	4	15	Case series
Glynn M.K. et al.	1983	3	44	Cohort
Trail I.A.	1988	3	56	Cohort
Windhager R. et al.	1988	4	18	Case series
Høgh. J., Lund. B.	1988	4	7	Case series
Binazzi R. et al.	1993	3	26	Cohort
Flowers M.J. et al.	1995	4	35 (42 knees)	Case series
Orava S. et al.	2000	4	70	Case series
DeBerardino T.M. et al.	2007	4	1	Clinical Case
Weiss J.M. et al.	2007	4	16/15	Case series
Beyzadeoglu T. et al.	2008	4	1	Case
Shishov M.A.	2008	4	1	Case
Harri K. Pihlajamäki et al.	2009	4	107 (117 knees)	Case series
El-Husseini T.F. et al.	2010	4	37	Case series
Lee Y.S. et al.	2011	4	1	Clinical Case
Nierenberg G. et al.	2011	4	22	Case series
Topol G.A. et al.	2011	2	54 (65 knees)	RCT
Krylov N.K.	2014	4	141	Case series
Lui T.H.	2015	4	1	Clinical Case
Narayan N. et al.	2015	4	1	Clinical Case
Eun S.S. et al.	2015	4	18	Case series
Pagenstert G. et al.	2017	4	7	Case series
Circi E. et al.	2017	4	11	Case series
Dannenberg D.J. et al.	2017	4	2	Case series
Gorbatenko A.I. et al.	2017	4	12	Case series
Tsakotos G. et al.	2020	4	1	Clinical Case
Nakase J. et al.	2020	2	49	RCT
Kamiya T. et al.	2021	4	1	Clinical Case
Mun F. et al.	2021	4	6	Case series
Wu Z. et al.	2021	2	70	RCT

RESULTS AND DISCUSSION

Invasive methods of OSD management

According to the selected publications, it is possible to classify invasive methods of treatment for OSD into surgical and puncture methods. Among the surgical methods, there are open and minimally invasive techniques.

Puncture methods

Puncture methods imply the introduction of various drugs into the affected area and are used in childhood for a recurrent chronic course of OSD, when the growth zones are not yet closed and operations on the apophysis zone can lead to complications.

Thus, D.J. Danneberg reports on the successful implementation of PRP-therapy to relieve the pain syndrome in OSD. The author does not report post-injection complications in any patient. After one injection, a subjective decrease in pain by about 50 % was observed, after 3-6 weeks pain was completely absent, and patients could return to an active lifestyle and sports [9]. The limitation of this study is the

sample size (two patients) and the short observation time.

A.I. Gorbatenko and V.L. Coolidy conducted a study on the effectiveness of PRP-therapy in combination with exercise therapy and physiotherapy in 12 patients, and reported positive results of treatment [10]. However, in their study, the patients received multicomponent treatment. Along with the puncture method, various types of conservative therapy were used: lifestyle correction, physiotherapy, therapeutic exercises. The study did not have comparison of the effectiveness of the proposed approach with other methods, in particular, with conservative treatment without PRP-therapy. Thus, it is not possible to conduct a reliable assessment of the effectiveness of the proposed multicomponent treatment.

I.I. Babich and M.A. Shishov described a method for treating OSD by introducing a composite implanted gel (collapAn-G) that stimulates reparative osteogenesis in the focus area. The procedure was performed at the age of 10-12 years, allowing treatment time reduction and good results [11]. After the procedure, the patient received a 10-day course of electrophoresis and limited the load on the limb for 3 months. The study refers to a comparison group with patients who received conservative treatment, however, the treatment method was not described. Nevertheless, the authors concluded that the injection therapy had obvious advantages.

A methodologically more rigorous randomized controlled trial of the treatment of OSD in children was performed by J. Nakase et al. [12]. Children, whose average age was 12-13 years, were randomly assigned to groups: punctures of 20 % dextrose and placebo (saline). There were no differences in long-term results between the groups. However, nine years earlier, G. Topol et al. conducted a randomized trial in 2011 and reported an acceleration of cure and improved outcomes in patients who underwent an injection of dextrose (12.5 %) and lidocaine [13]. Z. Wu et al. published data on the results of treatment of adult patients with an average age of 22 years in 2021 [14]. A randomized, double-blind study compared two groups of Chinese military personnel, one with injections of dextrose (12.5 %) and the other of saline into the tibial tuberosity. Six months and a year later, both groups had good to excellent results, but knee function and pain were lower in the dextrose group.

Surgical methods

The first works on surgical treatment of OSD date back to the 50^{s} of the 20th century [15, 16]. Classically, in the early works, an open method of treatment was used through a longitudinal incision in the projection of the patellar ligament, the removal of the inflamed tuberosity or its fragment was performed, followed by plasty of the ligament. Already in those works, the question of post-traumatic deformities after the complete removal of tuberosity was raised. In the study by M.A. Mital et al., which was performed on 118 patients (154 knee joints) after more than three and a half years of conservative treatment, the symptoms persisted only in those 14 patients (15 knee joints) in whom complete separation of the tuberosity fragment was radiographically preserved, those patients had an open removal of the fragment and they had complete healing [17]. In a number of original studies of OSD, which did not respond to conservative treatment, in an analysis of a series of clinical cases without a comparison group, a tuberosity fragment was removed with microperforation of the zone [18], and the scars were removed with good long-term results [19]. In most studies, the main cause of pain and, accordingly, OSD is the complete radiological and clinical separation of the fragment of the tibial tuberosity [20–25].

I.A. Trail compared conservative and surgical treatments (tibial sequestrectomy). During five years of observation of the results, the author concluded that no advantages of the surgical method of treatment over the conservative one were found [26]. It should be noted that patients in the conservative and surgical treatment groups did not receive any treatment before the study. Thus, the thesis about the need for surgery has been proved only in the case of a recurrent course of OSD that is not amenable to conservative treatment.

Flowers M.J. et al. in 1995, in a study of 35 patients who underwent open surgery for OSD, found relief of pain in 95 %, but 10% noted a sensation of scar tension in the area of the surgical approach [27]. Other disadvantages of the open direct approach are the appearance of pain in the area of the scar of the tuberosity when kneeling, which caused the development of anterolateral and lateral approaches [28, 29]. Comparing 4 anterior approaches in the treatment of BOSCH in military personnel, N.L. Krylov noted the best results with lateral approaches [1]. In addition, dissection of one's own ligament requires its plasty, including the use of anchor fixators [30]. Another disadvantage of the open technique is the need for plasty of the ligament followed by immobilization [31].

As an alternative to resection of tuberosity fragments, a number of authors described osteosynthesis in case of traumatic fracture of the tuberosity fragment in isolated cases in young (under 16 years old) athletes with OSD [32, 33].

Due to shortcomings of open interventions, an arthroscopic method for OSD was proposed [34]. Among the advantages of the method are the preservation of the patellar ligament, the scar outside the tuberosity, the possibility of arthroscopic revision of the knee joint. The experience was repeated by other authors, publishing single clinical cases [35, 36] and a series of clinical cases with long-term good and excellent results of treatment in 11 patients [37]. Lui T.H. described in detail the technique of arthroscopic debridement and noted that the preservation of the patellar ligament allows one to avoid postoperative immobilization [38], which was repeated by other researchers [39], who noted the

need for fluoroscopic control of intraoperative fragment removal. Choi W. performed arthroscopic resection of a rather large tuberosity fragment that penetrated into the joint, and stated the advantages of the arthroscopic method of treating OSD [40].

In 2015, Eun S.S. et al. proposed a direct bursoscopic approach to the tuberosity, as opposed to an arthroscopic approach, which consists of different arrangement of the portals to avoid the release of intra-articular fat. Twenty-two patients underwent this surgery; however, only 18 patients were followed up 2 years after treatment. It was found that with overall good and excellent results, 20 % noted pain in the kneeling position [41].

Kamiya T. and co-authors published a clinical case of OSD treatment using nanoarthroscopy under ultrasound guidance. The nanoarthroscope has a 1.9 mm optic system and corresponding instruments, which are much smaller than standard ones. The general concept of the authors is minimal invasiveness for the purpose of early rehabilitation [42].

CONCLUSION

Osgood-Schlatter disease is a condition that restricts the activity of athletes in childhood and adolescence. It can be cured by limiting the load and conservative treatment. In some patients, at an adult age, pain syndrome may persist. It is associated with the separation of fragments of the tuberosity, their tension during movement and the occurrence of apophysitis. Most of the methods of treatment are pathogenetically aimed at eliminating the inflamed focus by removing it or by conducting conservative anti-inflammatory therapy. At a younger age, in some cases, dissection of the scars and perforation of the fragment stimulate the reparative processes for fusion of the tubercle fragment instead of removing it.

Despite the benign course of the disease and the effectiveness of conservative treatment, a number of patients still have complaints associated with pain in the anterior part of the knee joint and are not able to return to sports. The evolution of surgical treatment methods is moving from direct open operations to minimally invasive ones. However, studies suggesting these techniques are low in the hierarchy of evidence; there are no large comparative studies that could show the difference between open and arthroscopic methods or their variations. Due to the rarity of surgical treatment of this pathology, it makes sense to create a register of patients with OS disease for the purpose of a remote unified assessment of the results of treatment in order to find the optimal surgical method.

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