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Systematic Review

Return to Sport after Pediatric Osteochondral Lesions: A Systematic Review

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Abstract: Background: Evidence on return to sport (RTS) criteria and timelines for pediatric patients with osteochondral (OCD) lesions of the foot and ankle is limited. Methods: This systematic review evaluated RTS criteria and outcomes in this population by querying PubMed, Embase, Web of Science, CINAHL, and SPORTDiscus up to 30 May 2024. Inclusion criteria were retrospective or prospective studies that examined pediatric patients with osteochondral lesions of the foot and ankle and gave outcomes or criteria regarding RTS. Results: Five observational studies (n = 168 patients; n = 180 OCD lesions; mean age: 14.19 ± 0.47 years; mean follow-up: 42 ± 174 months) were included. Two studies (40%) used time-based criteria for RTS, two studies (40%) used mixed criteria, and the final study (20%) used milestone-based criteria. Across the mixed and milestone criteria, physical therapy (n = 3) and minimal partial weight-bearing prior to RTS (n = 4) were most frequently seen as the milestones used for assessing RTS readiness. RTS from the postoperative period ranged from 3 months to 6 months. At the final follow-up, 61.45% of patients (n = 110) were available to provide information regarding their ability to RTS. Of these patients, 80% (n = 88) achieved RTS. Conclusions: Results showed variability in RTS criteria, ranging from three to six months, with no clear patterns. Most patients returned to sport, suggesting that such individualized criteria may be effective to an extent. Future research should focus on larger, high-quality studies to develop consistent RTS protocols.

Keywords: osteochondral lesion; pediatrics; return to sport; foot and ankle; talus

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1. Introduction

Over the past few decades, the recognition and diagnosis of osteochondral (OCD) lesions in the pediatric population have risen, largely due to advancements in imaging techniques and heightened awareness of this pathology among clinicians [1–3]. OCDs, involving damage to the cartilage and underlying bone in joints, are most commonly observed in the distal femur and ankle, particularly the talar dome, but can also occur in the knee and elbow [3–7]. Non-operative management of OCD lesions, such as rest and physical therapy, may result in variable outcomes, with many cases requiring surgical intervention to restore joint function and prevent long-term complications and progression to osteoarthritis [8–10]. Surgical techniques such as microfracture, osteochondral autograft transfer, and autologous chondrocyte implantation have shown promising results, with varying success rates depending on lesion size, location, and patient age [11–15].

Young athletes with OCDs of the foot and ankle have high expectations regarding their return to sport (RTS), and achieving this goal in a timely manner is often a primary concern for both patients and their caregivers. However, the timeline and success rate for RTS after the treatment of OCD lesions in the general athletic population can vary widely, influenced by factors such as lesion size, location, and the chosen treatment modality [11,16,17]. Postoperative rehabilitation plays a critical role in ensuring a safe and successful RTS, helping to restore joint function but also minimizing the risk of re-injury and long-term complications [18–21]. However, considerable variation in the RTS criteria has been seen across studies in patients with OCD lesions. Likewise, this topic has come under recent investigation in ACL reconstruction, with some criteria being time-based and others milestone-based, greatly confusing the practical application of RTS guidelines after ACL reconstruction for front-line practitioners [22]. This variability is further seen in pediatric patients, a population that has been understudied regarding the ability of young athletes to achieve adequate RTS and the time required to do so.

Given the lack of standardized, high-quality evidence to guide RTS rehabilitation after treatment for pediatric OCDs of the foot and ankle, the aim of this systematic review is to evaluate the existing literature on RTS criteria and outcomes for pediatric patients who have undergone treatment for OCD lesions. By synthesizing the current evidence, we hope to provide clearer guidelines for RTS, understand how successful RTS is in pediatric populations, and identify areas for future research to improve the management and rehabilitation of pediatric patients with OCD lesions of the foot and ankle.

2. Methods

2.1. Study Creation and Initial Search

This study is a qualitative systematic review of the literature examining pediatric osteochondral lesions and return to sport criteria using PubMed, Embase, Web of Science, CINAHL, and SPORTDiscus from database inception until 30 May 2024. Search terms used in each database were: (sport OR rehab* OR management OR "physical therapy") AND (osteochondral OR osteochondritis) AND (talocrural OR ankle OR talus OR foot OR tibiotalar OR tibia) AND (pediatric* OR child* OR teen* OR adolescent* OR preadolescent OR juvenile OR "skeletally immature"). This study was performed under the guidelines of the most recent Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA) for proper data reporting. This systematic review was retrospectively registered in the Open Science Framework Registries and can be found at https://doi.org/10.17605/OSF.IO/9XZQJ.

2.2. Inclusion and Exclusion Criteria

Inclusion criteria included retrospective or prospective studies that examined pediatric patients (age < 18) with osteochondral lesions of the foot and ankle and gave outcomes or criteria regarding RTS. The exclusion criteria included studies that were case series, non-pediatric patients, studies that did not include RTS as a study factor, and those that were not in the English language.

2.3. Article Screening Process

After the search algorithm was executed in each of the four databases for the initial search, all articles were uploaded into Rayyan, a public website used for systematic reviews [23]. One individual screener performed a manual de-duplication of articles. One independent reviewer performed article screening based on title and abstract, followed by full-text screening based on inclusion and exclusion criteria (J.L.). Lastly, the references for each included article were manually searched for articles that had not been initially captured. Any conflicts during the article screening process were resolved by the first author.

2.4. Study Definitions

Time-based criteria for RTS were defined as any study that used a set time period for patients to meet before being able to RTS (e.g., 3 months after surgery). The milestone-based criteria were defined as any study that used a physical checkpoint to assess recovery (e.g., dorsiflexion of the ankle > 20 degrees). Mixed criteria are defined as a combination of the former criteria.

2.5. Data Extraction

Data extraction was completed by two authors (J.L. and S.P.). Data extracted included first author, year of publication, procedure type, number of patients, average age, follow-up time, time to RTS, percentage that achieved RTS, and any other relevant qualitative data with associated *p*-values for narrative reporting.

2.6. Article Quality Grading

All observational studies included in this systematic review were classified as either "comparative" or "non-comparative" to appropriately grade their quality using the Methodological Index for Non-Randomized Studies (MINORS) scale for bias assessment [24]. Comparative studies were graded out of 24 points, and non-comparative studies were graded out of 16 points. For comparative studies, there are 8 items on the scale, and for non-comparative studies, there are 12 items on the scale, with each item being rated from 0 to 2 points. All articles were considered to be "high-quality", "moderate-quality", or "low-quality" based on their scoring and comparative/non-comparative nature. For comparative studies, high-quality articles scored 24 points, moderate-quality articles scored 15–23 points, and low-quality articles scored less than 15 points [25]. For non-comparative studies, high-quality articles scored 16 points, moderate-quality articles scored 10–15 points, and low-quality articles scored less than 10 points [25].

2.7. Statistical Analysis

This study utilized the Statistical Package for the Social Sciences (SPSS) version 29.0 (Armonk, NY, USA: IBM Corp) for statistical analysis. Frequency-weighted means (FWM) and other descriptive statistics were used to describe the data where no statistical significance could be calculated.

3. Results

3.1. Initial Search Results

The database search resulted in 1060 articles; after automated de-duplication, 700 articles remained. After title and abstract screening, 75 articles were included in full-text analysis. After reviewing articles in full, five articles met the inclusion criteria and were included in the data extraction process [11,26–29] (Figure 1).

3.2. Article Quality Results

Of the five included articles, all were retrospective observational studies (Table 1). There were four non-comparative studies and one comparative study. The overall mean MINORS score was 11.0 ± 2.35 points. The mean MINORS score for non-comparative studies (n = 4) was 10.0 ± 0.82 points (out of 16.0 points). The comparative study had a MINORS score of 15 out of 24. Ultimately, four articles were "moderate quality", one article was "low quality", and none of the articles were "high quality" (Table 1).

3.3. Patient and Study Characteristics

In total, 168 pediatric patients with a total of 180 reported OCD lesions (FWM age: 14.19 ± 0.47 years, FWM follow-up time: 42 ± 174 months) were included in this review (Table 2). Females comprised 71.71% of the cohort. All patients sustained osteochondral lesions of the foot and ankle resulting from varying mechanisms and pathologies. The included studies were performed in Japan (n = 2), USA (n = 1), UK (n = 1), and Austria (n = 1).

3.4. RTS Achievement and Criteria

Two studies (40%) used time-based criteria for RTS, two studies (40%) used mixed criteria, and the final study (20%) used milestone-based criteria. Across the mixed and milestone criteria, physical therapy (n = 3) and minimal partial weight-bearing prior to RTS (n = 4) were most frequently seen as the milestones used for assessing RTS readiness. RTS from the postoperative period ranged from 3 months to 6 months. All five studies (100%) provided information regarding the number of patients who achieved RTS. At the final follow-up, 61.45% of patients (n = 110) across the entire cohort were available to provide information regarding their ability to RTS. Of these patients, 80% (n = 88) were able to RTS (Table 3).

Table 1. The Methodological Index for Non-Randomized Studies (MINORS) grading for all included articles in this systematic review.

First Author (Year)	Study Type	Total MINORS Score	Clearly Stated Aim	Inclusion of Consecutive Patients	Prospective Collection of Data	End Points Appropriate to Study Aim	Unbiased Assessment of Study End Point	What Follow-Up Period Appropriate to Study Aim	Less than 5% Lost to Follow Up	Prospective Calculation of the Study Size	Adequate Control Group	Contemporary Groups	Baseline Equivalence of Groups	Adequate Statistical Analysis
Kramer et al. (2015) [27]	Non-comparative	9 (low)	2	2	0	2	0	2	0	1	-	-	-	-
Pallamar et al. (2022) [28]	Comparative	15 (moderate)	2	2	0	2	0	2	1	0	2	2	0	2
Vasukutty et al. (2011) [29]	Non-comparative	10 (moderate)	2	2	0	2	0	2	2	0	-	-	-	-
Tomonaga et al. (2024) [11]	Non-comparative	11 (moderate)	2	2	0	2	0	2	2	1	-	-	-	-
Ishimatsu et al. (2017) [26]	Non-comparative	10 (moderate)	2	2	0	2	0	2	2	0	-	-	-	-

Table 2. Study demographics table with relevant study characteristics such as number of patients, FWM age, number of males and females, and FWM follow-up time. Lesion location is shown as a number of lesions (n) if specified by the study. If the number of lesions was unspecified but the entire cohort had only one lesion location, a percentage of patients with that lesion location of the lesion is shown instead.

Author (Year)	Patients (n)	Age	Males/Females	Follow-Up	Lesion Location
Kramer (2015) [27]	100 (109 ankles)	14.3 ± 2.3	Male (n = 25) Female (n = 75)	39.6 months	Medial talus (n = 80) Lateral talus (n = 21) Central talus (n = 5) Distal tibia (n = 2)
Pallamar (2022) [28]	30 (32 ankles)	14.7 ± 2.2	Male (n = 15) Female (n = 15)	72.5 months	Talus; 100%
Vasukutty (2011) [29]	12	13.5	-	24 months	Location mixed; not specified
Tomonaga (2024) [11]	16 (17 ankles)	13.2 ± 1.5	Male (n = 6) Female (n = 10)	53.5 months	Talus; 100%
Ishimatsu (2017) [26]	10	14.8 ± 1.5	Male (n = 1) Female (n = 9)	24.6 months	2nd metatarsal head (n = 7) 3rd metatarsal head (n = 2) 4th metatarsal head (n = 1)

Table 3. Details of RTS definition, RTS criteria, criteria type (milestone, time-based, or mixed), number of patients that achieved RTS, and reported time to RTS.

Author (Year)	RTS Definition	RTS Criteria	Criteria Type	RTS % (n)	Time to RTS
Kramer (2015) [27]	Return to their competitive sport play	Formal physical therapy initiated at 6 weeks, focusing on range of motion (ROM) and strengthening. Return to impact sports was allowed at the surgeon's discretion starting 3 months after surgery based upon clinical symptoms, physical examination, and imaging.	Mixed	84% (n = 37/44)	Median: 6 months
Pallamar (2022) [28]	Perform sports without limitation	Partial weight-bearing for 4 weeks with stepwise progression to full weight-bearing within an additional 2–4 weeks. Physical therapy was prescribed to assist in strengthening, coordination, and functional recovery.	Mixed	53.1% (n = 17/32)	No time specified
Vasukutty (2011) [29]	Return to their competitive sport play	Patients mobilized with partial weight-bearing crutches were allowed to increase to full-weight-bearing as pain allowed. Physiotherapy was utilized to enhance ROM and proprioception when required.	Milestone	100% (n = 7/7)	No time specified
Tomonaga (2024) [11]	Return to same sport and same level of competition	Postoperative non-weight-bearing activity allowed for 3 weeks, followed by partial weight-bearing activity. Full weight-bearing activity allowed at 7 weeks after surgery. ROM exercises commenced without limit. Ankles with repaired lateral ligaments were splinted for 1 week. RTS was allowed 6 months after surgery.	Time-based	100% (n = 17/17)	Mean: 6 months
Ishimatsu (2017) [26]	Return to the same sporting activity undertaken preoperatively	Return to sporting activity was allowed from 3 months postoperatively.	Time-based	100% (n = 10/10)	Mean: 3.5 months

3.5. Clinical Outcomes Following Surgery Using Time-Based RTS Criteria

Ishimatsu et al. (2017) evaluated the sporting activity of pediatric athletes (n = 10) after osteochondral autograft transplantation (OAT) as a method to treat osteochondrosis of the metatarsal head [26]. The ability of patients to RTS was evaluated, with the Halasi score implemented to reflect the level of sporting activity and the Lysholm knee scale score to evaluate donor knee pain (Table 4). Ishimatsu et al. (2017) found that the mean Japanese Society for Surgery of the Foot (JSSF) lesser score was significantly improved at the final follow-up ($p < 0.01$). The mean range of motion (ROM) in extension and flexion improved at the final follow-up ($p < 0.01$ and $p < 0.05$, respectively). One hundred percent of patients achieved RTS at a mean time of 3.5 months postoperatively, and the Halasi score showed no significant change. Tomonaga et al. (2024) evaluated RTS for 16 skeletally immature pediatric athletes with OCD lesions (17 ankles) who underwent microfracture [11]. They found that 100% of patients who underwent microfracture for OCD lesions achieved RTS, with the mean JSSF score significantly improved from 76.1 points preoperatively to 94.9 points at the final follow-up ($p < 0.01$). The microfracture procedure was observed to significantly decrease lesion size from 76.3 to 56.7 mm^2 in area (p = 0.02) and from 283.2 to 185.6 mm^3 in volume (p = 0.05). They concluded that microfracture may be considered an effective first-line treatment for OCD lesions <10 mm in diameter in skeletally immature athletes.

Table 4. Clinical findings consisting of Berndt and Hardy lesion staging, patient-reported outcomes (PROs), and radiographic outcomes.

Author (Year)	Berndt and Harty Stage	PROS	Radiographic Outcomes
Kramer (2015) [27]	I: n = 14, II: n = 50, III: n = 16, IV: n = 3	Average FAOS score: 77 ± 18; Symptoms FAOS: 73 ± 21; Pain FAOS: 81 ± 21; Function/Sports FAOS: 76 ± 19; ADLs FAOS: 91 ± 15; QOL FAOS: 64 ± 25; Total FAOS: 385 ± 90	Healed lesion (n = 13, 16%); Improved lesion (n = 51, 64%); Unchanged lesion (n = 14, 18%); Worse lesion (n = 2, 3%)
Pallamar (2022) [28]	I: n = 11, II: n = 11, III: n = 6, IV: n = 0	Berndt: I, NRS 2.2 ± 2.4, AOFAS 93.4 ± 9.4, FFI 7.3 ± 0.1. Berndt: II, NRS 3.5 ± 2.1, AOFAS 86.9 ± 9.8, FFI 15.0 ± 0.1. Berndt: III, NRS 3.3 ± 2.1, AOFAS 90.8 ± 12.2, FFI 13.3 ± 0.1	Complete OCL restoration (n = 6); Mild signs of joint degeneration (n = 16)
Vasukutty (2011) [29]	-	Average FAOS score: 87 with complete relief of symptoms at 3 months	-
Tomonaga (2024) [11]	Pre: I: n = 4, II: n = 4, III: n = 7, IV: n = 2. Post: normal: n = 3, I: n = 12, II: n = 2, III: n = 0, IV: n = 0	JSSF Score Pre: 76.1, Post: 94.9. AAS Score: Pre: 6.5, Post: 6.4	Radiographic Stage decreased in 13 of 17 ankles. In three ankles, OLT was not detectable.
Ishimatsu (2017) [26]	-	Halasi score Preop: 6.5 ± 1.5; Postop: 6.0 ± 1.8 (p = 0.18)	Radiographs at the final follow-up revealed an adequate configuration of the metatarsal head without osteoarthritic changes in the operated MTP joint. In eight patients, MRI at the final follow-up showed consolidation between the transplanted osteochondral autograft and the subchondral bone and smooth configuration of the articular surface of the metatarsal head with presentation of the transplanted cartilage.

3.6. Clinical Outcomes Following Surgery Using Milestone-Based RTS Criteria

Vasukutty et al. (2011) retrospectively analyzed outcomes of ankle arthroscopy in 12 pediatric patients with 15 OCD lesions [29]. There were three cases where OCD was seen by MRI, and the cartilage was found to be intact on arthroscopy, confirming these to be grade-1 OCDs. Arthroscopic findings identified two grade-4 lesions, three grade-3 and seven grade-2 lesions. They observed ankle arthroscopy to successfully enable 100% of patients who played sports (n = 7/7) to achieve RTS. Additionally, they concluded that MRI was found to be insensitive for the diagnosis of soft tissue impingement of the ankle.

3.7. Clinical Outcomes Following Surgery Using Mixed RTS Criteria

Kramer et al. (2015) aimed to identify the patient and lesion characteristics linked to surgical success and failure while also reporting on the functional outcomes in 100 patients surgically treated for OCD of the ankle (109 ankles) [27]. They observed OCD lesions to be most commonly found on the medial talus (n = 80, 73%). The most frequently performed procedures were transarticular drilling (59, 54%), fixation (22, 20%), and excision microfracture (27, 26%), with an overall reoperation rate of 27% (n = 29/109). 82% (n = 36/44) of survey respondents were satisfied, and 84% (n = 37/44) returned to sports at a median time of 6 months. The average FAOS score was 77 ± 18, and multiple linear regression confirmed that female sex and elevated body mass index were significant negative predictors for FAOS score. Most importantly, Kramer et al. (2015) found that reoperation rates after surgical intervention were significantly higher for OCD lesions in which postoperative radiographs had no change or looked worse (10/16, 63%) (p = 0.002) [27]. Pallamar et al. (2022) assessed the clinical and radiographic outcomes of different surgical procedures in atraumatic OCD lesions caused by osteochondrosis dissecans of the talus in 30 pediatric patients (32 joints) and reported outcomes regarding RTS [28]. They found that patients who underwent retrograde, transarticular, or transarticular–transmalleolar drilling group showed significantly better scores than the combined fixation and reconstruction groups (American Foot and Ankle Scale for Hindfoot (AOFAS, p = 0.024; Pediatric Outcome Data Collection Instrument (PODCI), p = 0.003; NRS, p = 0.027). Signs of joint degeneration were observed in 50% of all ankles, especially in those treated by fixation and reconstruction. They observed that a greater proportion of patients in the drilling group (n = 11/14; 79%) were able to perform sports without any limitations. In contrast, unlimited sports participation was only possible in 50% (n = 4/8) patients after transfixation and in 20% (n = 2/10) patients after OCD reconstruction. They concluded that fixation and reconstruction procedures in unstable and non-salvageable atraumatic talar lesions resulted in inferior clinical scores and a higher prevalence of joint degeneration than drilling procedures in stable OCD in pediatric patients [28].

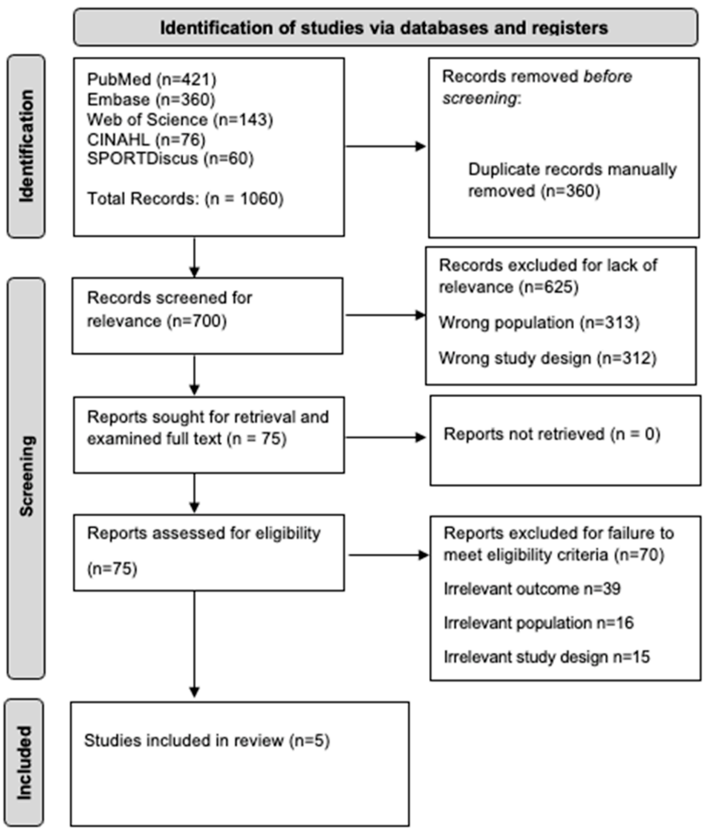

Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram for this study outlines the initial search process, various article screenings, and final article inclusion.

4. Discussion

This study investigated the RTS timeline for pediatric patients following surgical intervention for OCD lesions of the foot and ankle. This is an important area of investigation, given that OCD lesions in young patients, especially athletes, often result from acute trauma or repetitive stress and can severely impact joint function and athletic performance. Surgical intervention is frequently required to repair these lesions and restore joint integrity. Our systematic review aimed to synthesize the available data on RTS post-surgery, evaluating the criteria for RTS, the number of patients that achieved RTS, and any factors that influence recovery. The findings from our review present a complex and varied picture. The RTS times ranged between three to six months among the included studies, with no clear patterns emerging, which further prevented any statistical comparisons from being made. This variability suggests that the recovery process is highly individualized and influenced by multiple factors, including the severity of the lesion, the specific surgical technique used, and the patient's overall health and rehabilitation adherence. Consequently, while some patients were able to RTS within a few months, consistent follow-up was still required for adequate monitoring of injury healing over the course of one year at minimum and ranging to seven years. Our findings also revealed that criteria regarding RTS were seen to be highly dependent on surgeon preference, injury severity, and individual goals of the patient with mixed approaches using milestone and time-based criteria. This highlights the need for a cautious and personalized approach to post-surgical rehabilitation and RTS planning, with further research needed to develop clear guidelines for pediatric patients.

RTS is a crucial outcome for young athletes undergoing orthopedic surgery, as it can impact their physical development, eligibility to compete at professional levels, and overall psychological well-being [30,31]. Our findings revealed that regarding time-based criteria for RTS following OCD of the foot and ankle, surgeons tended to allow RTS over the course of 3–6 months. This was a quicker RTS than initially hypothesized, but it may be due to placing a greater emphasis on individual patient-specific factors in determining an adequate recovery timeline. Such an approach seems to be consistent with existing literature on RTS times in orthopedic surgery. For instance, Dumont et al. (2012) demonstrated that factors such as increased age and weight were independently associated with a higher rate of secondary medial meniscal tears and chondral injuries in patients with preexisting ACL [32]. They also observed that the time to treatment after the initial ACL tear significantly influenced the development of a secondary meniscal tear, advising that such comorbid factors should be accounted for when considering overall recovery and rehabilitation. Similarly, the current study also had varying patient factors that influenced recovery, healing, and, subsequently, RTS. For example, although all were pediatric in nature, the pathology giving rise to the OCD lesions varied, with variable surgical approaches implemented and varying levels of skeletal maturity of the patients. In the absence of clear RTS guidelines, surgeons may have recognized that more active, athletic patients may highly prioritize a faster RTS and may possess the capacity for more rapid recovery. These realities may indicate the use of differential criteria to determine RTS for such patients. Additionally, some patients may possess fewer risk factors, such as varying levels of skeletal immaturity, which may have enabled them to allow sooner RTS when using a time-based approach. Though this factors into the variability of the data we observed, the overall time observed for patients to RTS (3–6 months) was actually similar to other orthopedic injuries.

For example, when comparing RTS time criteria for OCD lesions to other pediatric ankle conditions, our findings suggest that OCD lesions in pediatric patients seem to have a recovery period similar to that of other surgically treated ligamentous injuries. Lorange et al. (2024) observed that the quickest RTS after anterior cruciate ligament (ACL) reconstruction in children was 5.8 months, and the longest was 9.6 months, a timeframe similar to that observed in the current review. The slightly longer RTS observed in pediatric ACL reconstructions may be explained by significant risk factors such as graft rupture, younger age, and resuming sports activity without adequate rehabilitation protocol, as suggested by Lorange et al. (2024). Though the risk factors were not evaluated by many of the included studies in the current review, we hypothesize that more severe injuries and a delayed time to surgery would result in further delayed RTS, which is recognized throughout the literature [33–35].

The RTS time period for OCD lesions was also similar to other conditions involving cartilage damage. For example, Lee et al. (2019) noted that athletes undergoing isolated meniscal repair had an average RTS of 5.6 months [36]. Furthermore, they noted that the time to RTS was longer for athletes who required concurrent ACL reconstruction, which supports the slightly longer RTS time observed by Lorange et al. (2024). Unfortunately, the evidence regarding RTS in cartilaginous injuries of the pediatric populations is limited, making commentary and comparisons on such pathologies in younger patients difficult. However, studies on more simple pediatric ankle conditions, such as fractures or ligament sprains, generally show quicker RTS timelines. A narrative review by Gill et al. (2018) suggested that patients with displaced fractures of the foot and ankle in pediatric patients can generally expect an RTS of around three to four months following surgical intervention [37]. To summarize, pediatric OCD lesions are observed to have similar RTS timelines as simpler injuries of the foot and ankle in young patients and cartilage injuries in adult patients, and may even be faster than ligamentous injuries such as ACL reconstructions in young patients. However, the data are still very preliminary and limited. Thus, further large cohort studies in this specific pediatric population are necessary to draw definitive conclusions.

With regards to percentages of patients who are able to return to pre-injury sporting activity, OCD lesions in pediatric patients have shown a relatively high RTS rate of around 80%. This is comparable to the 85–95% RTS rate observed in pediatric patients post-ACL reconstruction, as reported by Lorange et al. (2024) [22]. These results are in contrast to a 10-year follow-up study done by Zaffagnini et al. (2019), where the rate and level of RTS in a group of competitive athletes who underwent matrix-assisted autologous chondrocyte transplantation were examined [38]. In contrast to the current review, Zaffagnini et al. (2019) reported a low rate of return to pre-injury sport levels in athletes after cartilage surgery, with only 64% of patients able to return to a competitive level of sport. They found that in patients with an average age of 22 years old, the RTS rate varied by specific patient and lesion characteristics, with the best results obtained in young patients with traumatic lesions without previous surgery. These findings suggest that early identification and treatment of OCD lesions in young patients may enhance surgical outcomes and RTS rates.

Nonetheless, a major limitation across these studies is the lack of standardized RTS criteria. For example, even simple decision matrices such as whether to allow weight-bearing at 6 weeks or instead use a functional outcome metric as a benchmark to assess if RTS is safe remain yet to be widely agreed upon. Similar to Lorange et al. (2024), many studies included in this review used milestone-based, time-based, or mixed approaches for RTS criteria. For pediatric ACL reconstruction, Lorange et al. (2024) recommended delayed RTS, when possible, in younger patients. They further recommended a combination of quantitative tests and qualitative tests prior to RTS. However, the optimal RTS criteria were unable to be determined by Lorange et al. (2024) and other authors investigating RTS criteria in the field of ACL reconstructions have experienced similar difficulty recommending definitive criteria [39–41]. Reviewing the current evidence on pediatric OCD lesion RTS criteria has similarly shown limited and varied criteria being employed by physicians to assess if a patient is ready to engage in sporting activity. However, given the relatively high rate of RTS observed, it may be worth investigating whether the milestone or time-based criteria even make a significant difference in overall RTS rates in patients. Additionally, the consideration of skeletal maturity is crucial when determining the rehabilitation protocol for young patients. The studies reviewed were not consistent in their assessment of physeal status. Although these patients are minors, some individuals under 18 may exhibit adult-like physiological characteristics. This variation can significantly impact their rehabilitation and RTS outcomes, highlighting the need for maturity-specific rehabilitation strategies [42–44].

This study must be considered with respect to its limitations. The quality of our findings is constrained by the included studies, which were primarily retrospective and varied in sample size. The small number of studies and limited patient data restrict the strength and power of the associations that can be drawn from our results. Furthermore, most of the studies included were of low to moderate quality, with no high-quality studies meeting the inclusion criteria, affecting the overall reliability of our conclusions. Additionally, there was considerable variability in the surgical approaches and rehabilitation protocols employed across the studies, preventing a thorough comparative analysis. Different surgeons used various techniques, including microfracture, OAT, and transarticular drilling, which led to heterogeneous data. The variability in patient demographics, such as lesion severity, comorbidities, level of activity prior to injury, and follow-up durations, introduces further confounding factors that complicate direct comparisons. The definitions of RTS criteria were also inconsistent amongst studies, with some studies using time-based criteria, others using milestone-based criteria, and some employing a mixed approach. This inconsistency in defining RTS adds another layer of complexity to interpreting the findings. Future research should aim to include larger cohorts and utilize high-quality, prospective study designs. Standardizing surgical techniques, rehabilitation protocols, and RTS criteria definitions, as well as controlling for additional confounding variables, may help provide more definitive conclusions and improve the management and rehabilitation of pediatric patients with OCD lesions. This study, while attempting to comment on RTS protocols for foot and ankle OCDs, also serves to highlight the paucity of high-quality research surrounding pediatric foot and ankle OCDs.

5. Conclusions

Our study reviewed the RTS criteria currently employed for pediatric patients after surgery for OCD lesions of the ankle. We also reviewed the number of patients who successfully achieved RTS. The results showed a wide range of times at which surgeons deemed RTS safe, typically from three to six months. No clear patterns were seen due to the variability in study designs and limited data, though individualized approaches seemed to guide postoperative RTS decision-making. Still, a large proportion of pediatric patients were observed to have RTS within a few months post-surgery. This may indicate that individualized, patient-specific RTS criteria may complement the search for developing overarching general guidelines. Future research should focus on larger, high-quality studies to aid in the understanding of the effect of different RTS criteria on the number of patients that achieve RTS and how this impacts re-injury and reoperation toward the development of more consistent protocols to improve outcomes for young athletes with OCD lesions.

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