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Surgical management of osteochondritis dissecans of the knee in the paediatric population: a systematic review addressing surgical techniques

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Abstract
Purpose Several case series have been published exploring a variety of surgical treatments for osteochondritis dissecans (OCD) in patients 18 years and younger, but a systematic review is currently lacking. This systemic review identifies the various surgical techniques reported in the literature for treating OCD and assesses the effectiveness of these treatments based on functional outcomes and radiographic healing.
Methods A search of the EMBASE and MEDLINE databases was performed to identify clinical studies reporting outcomes of surgical management of OCD in the knee. A quality assessment of the included articles was conducted independently by 2 reviewers using a quality assessment tool developed by Yang et al.
Results A total of 25 papers including 470 patients aged ≤18 years (516 lesions) met the eligibility criteria and were reviewed. Surgical techniques for stable lesions included (arthroscopic and open) transarticular drilling, either alone (41 %) or with bioabsorbable pin fixation (3 %), extra-articular drilling (29 %) and fixation with bioabsorbable screws (4 %) or bone pegs (4 %). For unstable lesions, surgical techniques included (arthroscopic and open) fixation with bioabsorbable pins (9 %), metal screws (4 %), bone pegs (4 %), osteochondral plugs (3 %) or bioabsorbable screws (2 %), as well as transarticular drilling with bioabsorbable pin fixation (3 %) and drilling with metal screw fixation (2 %).
Conclusion The most common techniques were transarticular drilling for stable lesions and bioabsorbable pin fixation for unstable lesions. The key findings were that the vast majority of lesions healed postoperatively, regardless of technique, and that high-quality trials are required to more appropriately compare the effectiveness of techniques.
Level of evidence Systematic review, Level IV.

Keywords Osteochondritis dissecans · Knee · Systematic review · Surgical treatment

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Introduction

The understanding of osteochondritis dissecans (OCD) has expanded since the condition was first described by Paget in 1870 to include a spectrum of presentations beginning with softening of the overlying articular cartilage and progressing to varying extents of osseous resorption, collapse and detachment, with possible violation of the overlying articular cartilage and, ultimately, loose body formation [6, 8]. Long-term implications can include pain, limitations of daily or sports activities, mechanical symptoms and arthrosis [1, 3, 23]. The aetiology may be multifactorial, with proposed causes including trauma, repetitive microtrauma, avascular necrosis of the subchondral bone, genetics, abnormal ossification patterns and endocrine abnormalities [2, 6–8, 14, 20]. Prevalence has been reported as 18–29 in 100 000 with an average age of onset ranging from 11.3 to 13.4 years [2], with males affected at twice the rate of females, although the prevalence in females has been increasing [7, 9].

Numerous surgical techniques have been described for the treatment of OCD lesions at different stages. Given the large number of techniques described in the literature, the question arises as to which of these techniques provide superior outcomes for lesions at different stages. Controversies exist regarding the best management of these lesions. This systematic review was undertaken to document the surgical techniques for this condition and summarize evidence for outcomes in patients 18 years of age and younger.

Materials and methods

One reviewer searched 2 databases (MEDLINE and EMBASE) for clinical studies regarding surgical management of OCD ("Appendix"). The search was conducted with the guidance of a library liaison at our institution (Jennifer McKinnell, Library Liason-Health Sciences Library McMaster University). Search terms included osteochondritis, loose bodies and knee. All clinical studies from 2000 to September 2011 were reviewed separately by 3 reviewers, and any disagreement regarding study inclusion was resolved by a consensus discussion. Given the rapid advancement of surgical techniques, the year 2000 was chosen to focus on the most relevant techniques to current practice.

The inclusion criteria for this review are as follows: (1) published between 2000 and September 2011, (2) stable and unstable OCD lesions of the human knee, (3) non-traumatic OCD lesion, (4) operative study, (5) subjects ≤18 years old and (6) written in English. The exclusion criteria are as follows: (1) non-clinical studies, (2) non-human studies, (3) traumatic OCD lesions, (4) review papers, (5) salvage procedures and (6) case reports (one or two people). Initially, a title and abstract review for eligible studies was conducted by two reviewers (Devin Peterson, Lauren Salci) and separately a third reviewer (Olufemi Ayeni). Next, a full-text review was carried out independently by all three reviewers. Any discrepancies were resolved by a consensus discussion. Lastly, the references for each article included in this review were hand-searched for other eligible studies.

Quality assessment of the included articles was conducted by 2 reviewers (Marcel Abouassaly, Lauren Salci). All case series were evaluated based on the adapted tool created and validated by Yang et al. [25]. The tool of Yang et al. showed a high level of consistency and meets content validity. A mean was calculated for any differing scores between reviewers.

Study information was abstracted and included authors, date of publication, study design, sample number, % of males and females, mean age and range, duration and type of symptoms, indications for surgery, lesion stability, type of surgery performed, follow-up length, outcome of surgery and complication rate.

Statistical analysis

Studies of any sample size were included. Summary numbers were calculated whenever the raw data were provided by the authors. The weighted means with the weighted standard deviations were calculated for demographics and outcome measures by the procedure type whenever more than one study was available for calculation using SPSS software. Where possible, pooled means were calculated for preoperative and postoperative Lysholm, Tegner and Hughston scores. For reliability data, mean with standard deviation was calculated for the quality assessment score for each of the reviewers. Intraclass correlation coefficient (ICC) two-way mixed effects model was applied to measure the level of agreement between the reviewers. Reliability with 95 % confidence intervals (CI) is reported. The Spearman's correlation coefficient analysis was used to measure the linear correlation between the outcome scores and different techniques.

Results

The literature review yielded 494 studies. Twenty-five of these met the inclusion criteria and were selected for this review, as demonstrated in Fig. 1. Table 1 shows the demographics of the included studies as well as the quality assessment scores. All studies (25) were Level IV studies (case series). The mean (standard deviation) quality assessment score was 11.8 (2.1) for reviewer Marcel Abouassaly and 10.9 (1.9) for reviewer Lauren Salci. The reliability of quality assessment between the reviewers was 92.5 % (95 % CI 83.0–97.0 %). The most common items which led to lower-quality scores included inadequate description of the condition being treated (32 %), inadequate details of methods/procedures to allow the study to be repeated (32 %), deficiencies in relevance and completeness of data (26 %) and poor clarity of reporting of results for all outcome measures (20 %).

Classification systems/outcome measures used

Radiographic classification systems used in the reviewed papers included Clanton and Delee, Bedouelle, Berndt and Hardy, Rodegerdts and Gleisner, and a perilesional ring classification (each in 4 % of studies). MRI classification systems included the Hefti (12 %), Nelson (8 %), Hughes (8 %), Dipaola (4 %) and Bruckl (4 %) classification systems. Arthroscopic classification systems

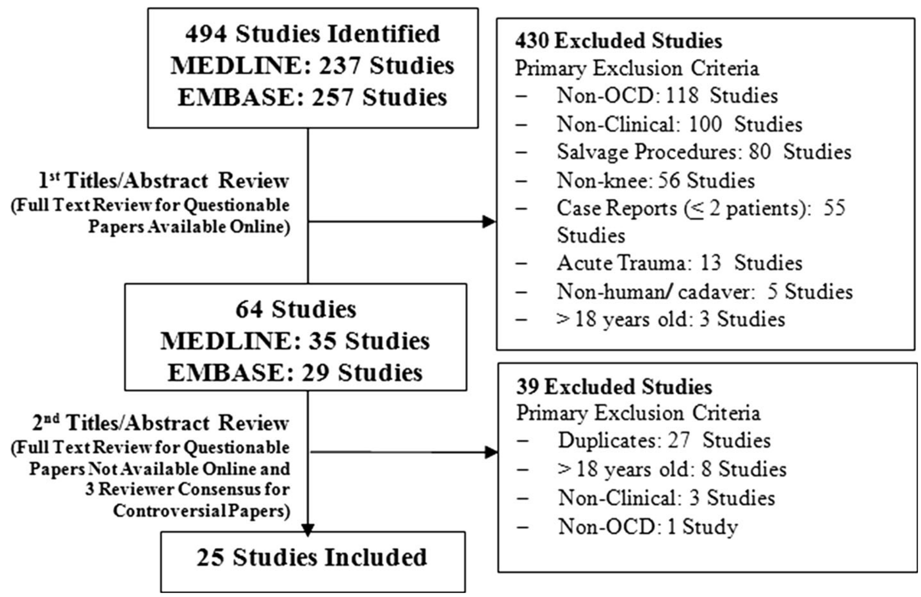

Fig. 1 Identification of included studies

Table 1 Characteristics of included studies

Study	Years	Location	% male	Mean age of participants (year)	Sample size	Quality score
Adachi et al. [1]	2009	Japan	83	12 (range 9–15)	12	12
Boughanem et al. [2]	2011	United States	68	12.6 (range 8–16)	31	13
Camathias et al. [3]	2011	Switzerland	75	12.3 (range 11–15)	16	11
Cepero et al. [4]	2005	Spain	73	12.6 (range 9–17)	67	8.5
Din et al. [5]	2006	Australia	82	14.8 (range 12–16)	11	11.5
Dines et al. [6]	2008	United States	86	14.9 (range 12–17)	7	13
Donaldson and Wojtys [7]	2008	United States	53	12.3 (range 9–15)	15	10
Edmonds et al. [8]	2010	United States	71	13.4 (range 8–18.6)	51	12.5
Kawasaki et al. [9]	2003	Japan	75	12.5 (range 9–16)	16	12.5
Kocher et al. [10]	2001	United States	65	12.3 (range 8.5–16.1)	23	12
Kocher et al. [11]	2007	United States	54	14.7 (range 11–16)	24	12.5
Kouzelis et al. [12]	2006	Greece	100	16.7 (range 15–18)	3	12.5
Louisia et al. [13]	2003	France	N/A	13.8 (range 11–17)	17	12.5
Magnussen et al. [14]	2009	United States	17	13.7 (range, 12–15)	6	12.5
Makino et al. [15]	2005	Argentina	63	14.6 (range 12–17)	8	13
Miura et al. [16]	2006	Japan	80	14.3 (range 11–18)	10	13
Nakagawa et al. [17]	2005	Japan	100	15.8 (range 13–18)	5	11.5
Navarro et al. [18]	2002	Brazil	44	15.2 (range 11–17)	9	11.5
Ojala et al. [19]	2011	Finland	57	12.4 (range 7–18)	7	10.5
Ramirez et al. [20]	2010	Spain	73	12 (range < 12– > 15)	85	12
Scioscia et al. [21]	2001	United States	67	16.7 (15–18)	3	9
Tabaddor et al. [23]	2010	United States	58	14.4 (range 10–18)	24	12
Tuompo et al. [23]	2000	Finland	43	16.2 (range 12–18)	14	12.5
Wouters et al. [24]	2003	Netherlands	67	15 (range 14–16)	3	7.5
Yoshizumi et al. [26]	2002	Japan	33	15.3 (range 12–18)	3	5

N/A Not available

included the Guhl arthroscopic staging system and the Ewing and Voto arthroscopic staging system (36 % combined), in addition to the ICRS system (4 %). Lesions were classified based on single or multiple modalities, employing established systems as well as subjective, descriptive assessments.

Table 2 Surgical techniques and classifications/outcome scores used

Surgical technique	Author	Device	Lesion status	Postoperative healing (imaging/arthroscopic)	Postoperative outcome score used
Bioabsorbable pins	Tabaddor et al. [22]	SmartNail (ConMed Linvatec)	"Unstable", Hefti MRI 2–5, Guhl/Ewing Voto arthroscopic grade 2–4	Descriptive radiographic healing	Lysholm, Tegner, IKDC
	Dines et al. [6]	SmartNail (ConMed Linvatec)	Dipaola MRI stage 2–3	Descriptive radiographic/MRI healing	Lysholm
	Kocher et al. [11]	SmartNail (ConMed Linvatec) or Orthosorb (Depuy)	"Unstable", Guhl/Ewing Voto arthroscopic grade 2–4	Descriptive radiographic healing	Lysholm, Tegner, IKDC
	Nakagawa et al. [17]	Neofix (Gunze)	"Unstable", Descriptive arthroscopy—detached in situ/detached	Descriptive radiographic healing	Paper-specific subjective scale
Transarticular drilling with Bioabsorbable pins	Wouters et al. [24]	Orthosorb (Depuy)	Descriptive arthroscopy—attached/detached	Descriptive MRI healing	N/A
	Din et al. [5]	1.2-mm K-wire and Smart Nail (ConMed Linvatec)	"Stable", Hughes MRI stage 2–4a, Guhl/Ewing Voto arthroscopic grade 1–2	Descriptive MRI healing	Hughston, Paper-specific subjective scale
Metal screws	Magnussen et al. [14]	1.5–2.7 mm metal cortex screws (Synthes)	"Unstable", Guhl/Ewing Voto arthroscopic grade 4	Descriptive arthroscopic healing	Marx, KOOS subtypes,
	Kocher et al. [11]	Herbert screw (Zimmer) or 3.5 mm cannulated screw (Synthes)	"Unstable", Guhl/Ewing Voto arthroscopic grade 2–4	Descriptive radiographic healing	Lysholm, Tegner, IKDC
Bone pegs	Nakagawa et al. [17]	Bone pegs from ipsilateral tibia	"Unstable", Descriptive arthroscopy—in situ detached	Descriptive radiographic healing	Paper-specific subjective scale
	Navarro et al. [18]	Bone pegs from ipsilateral tibia	N/A	Descriptive radiographic healing	Hughston
	Tuompo et al. [23]	Bone pegs from ipsilateral tibia	Guhl/Ewing Voto arthroscopic grade 1–4	Descriptive radiographic healing	Lysholm, Tegner, Hefti clinical
Bioabsorbable screws	Scioscia et al. [21]	2.7-mm PLA screw (± 1.5 mm bioabsorbable rod)	"Unstable"	Descriptive arthroscopic healing	N/A
	Tuompo et al. [23]	Threaded Biofix (ConMed Linvatec)	Guhl/Ewing Voto arthroscopic grade 1–4	Descriptive radiographic healing	Lysholm, Tegner, Hefti clinical
Extra-articular drilling	Boughanem et al. [2]	0.045-inch K-wire	"Stable", Hefti MRI stage 1–2	Descriptive radiographic healing	Lysholm, Tegner, Visual analog pain score
	Ojala et al. [19]	MRI-guided percutaneous	"Stable", Hefti MRI stage 1–2	N/A	Hughston
	Edmonds et al. [8]	0.062-inch K-wire	"Stable", Guhl/Ewing Voto arthroscopic grade 1–2	Descriptive radiographic healing	N/A
	Adachi et al. [1]	Fluoroscopy and 1.2-mm K-wire	"Stable", Nelson MRI 1–2	Descriptive radiographic healing	Lysholm, Hughston
	Donaldson et al. [7]	Various K-wires (all < 1 mm diameter)	"Stable", Descriptive arthroscopy intact cartilage	N/A	Paper-specific subjective scale

Table 2 continued

Surgical technique	Author	Device	Lesion status	Postoperative healing (imaging/arthroscopic)	Postoperative outcome score used
	Kawasaki et al. [9]	1.5-mm K-wire	"Stable", Nelson MRI 1–3, Descriptive arthroscopy intact-dimpled	Descriptive radiographic/MRI healing	Lysholm, Hughston
Transarticular drilling	Ramirez et al. [20]	Not specified	Perilesional ring radiographic stage 0–2	N/A	N/A
	Cepero et al. [4]	Not specified	"Stable" and "Unstable", Berndt and Harty Stage 1–4	N/A	N/A
	Louisia et al. [13]	1.5- or 2-mm drill	"Stable", Guhl/Ewing Voto arthroscopic grade 1–2, Bedouelle radiographic 1a–2	Descriptive radiographic healing	Hughston
	Kocher et al [10]	1.6-mm K-wire	"Stable", Rodegerdts and Gleisner grade 1–4	Descriptive radiographic healing	Lysholm
Differential pitch screws	Kocher et al. [11]	Herbert screw (Zimmer)	"Unstable", Guhl/Ewing Voto arthroscopic grade 2–4	Descriptive radiographic healing	Lysholm, Tegner
Osteochondral plugs	Miura et al. [16]	Osteochondral Autograft Transfer System (Arthrex)	"Unstable", Nelson MRI stage 3–4, ICRS-OCD arthroscopic-II–IV	Descriptive MRI healing	Hughston
	Yoshizumi et al. [26]	12 mm by 20 mm osteochondral plug	"Unstable", Bruckl MRI stage 2–4	Descriptive MRI/roentgenogram healing	Paper-specific subjective scale
Bioabsorbable lag screw	Camathias et al. [3]	SmartScrews (ConMed Linvatec)	"Stable", Guhl/Ewing Voto arthroscopic grade 1–3, Hughes MRI 2–4a	N/A	Hughston, Paper-specific subjective scale
Differential pitch screw with extra-articular drilling	Kouzelis et al. [12]	Herbert screw (Zimmer) and K-wire (otherwise not specified)	Clanton and Delee radiographic 3–4	Descriptive radiographic healing	Lysholm, ICRS scale
Differential pitch screw with drilling base of lesion (not transarticular)	Makino et al. [15]	Herbert screw	Guhl/Ewing Voto arthroscopic grade 1–3	Descriptive MRI/arthroscopic healing	Lysholm, ICRS scale, IKDC

N/A Not available

Table 3 Characteristics of patients included in statistical analysis

Total patients	412
Weighted mean male	2 (67.57 %)
Weighted mean age (SD)	13.3 (1.8)
Weighed mean area size (SD)	3.3 (1.8)
Weighted mean follow-up (SD)	50.9 (17.5)

Outcome scales used in the reviewed studies included the Lysholm Knee Scoring Scale (36 % of studies), Hughston Scale (32 %) and Tegner Activity Scale (16 %). A number of additional functional outcome scores as well as paper-specific subjective outcome scales were also employed in a limited number of papers. Surgical techniques used in the reviewed papers with corresponding radiographic, MRI and arthroscopic classification systems, imaging/arthroscopic assessment of healing and functional outcomes are outlined in Table 2.

Study characteristics

Demographic data for the 412 patients included in the statistical analysis are summarized in Tables 3 and 4. Older patients with mean age of >15 years were more likely to receive treatment with bone pegs or bioabsorbable screws, while younger patients with mean age of 12 had bioabsorbable lag screw, extra-articular drilling and transarticular drilling treatments. Patients with lesion size of 4.5 cm^2 or larger were more likely to be treated with bone pegs or bioabsorbable screw treatments, while patients with lesions of 3 cm^2 or less had treatment with bioabsorbable lag screw, extra-articular drilling, bioabsorbable pins and osteochondral plugs.

Weighted mean functional outcome scores were also calculated based on treatment type where they were reported. Heterogeneity of reported outcomes made consolidation of data impossible. These results are illustrated in Tables 5. Mean postoperative outcome scores ranged

Table 4 Calculated weighted means of baseline characteristics by surgical procedures

Treatment	Male (%)	Age	Area (cm^2)	Follow-up
Bioabsorbable lag screw				
N	N/A	16	16	N/A
Mean (SD)*	N/A	12.3 (1.3)	2.4 (2.4)	N/A
Bioabsorbable pins only				
N	35	35	35	31
Mean (SD)	68.6	14.6 (1.8)	3.0 (2.0)	38 (15)
Bioabsorbable screw				
N	5	8	5	5
Mean (SD*	60	16.3 (2.0)	4.5 (3.6)	81 (30)
Bone pegs only				
N	10	10	10	9
Mean (SD)*	50	16.5 (1.4)	5.8 (2.4)	94 (41)
Differential pitch screw and base drilling				
N	8	8	N/A	8
Mean (SD)*	62.5	14.6 (1.6)	N/A	55 (26)
Extra-articular drilling				
N	140	140	58	113
Mean (SD)	70.7	12.8 (1.7)	3.3 (1.6)	35 (10)
Metal screws				
N	6	6	6	6
Mean (SD)*	16.7	13.7 (1.2)	4.2	95 (39)
Osteochondral plugs				
N	10	13	10	10
Mean (SD)*	80	14.5 (2.3)	2.2 (1.0)	52 (12)
Transarticular drilling				
N	108	108	N/A	108
Mean (SD)	71.3	12.1 (2.4)	N/A	47 (17)
Combined treatments[a]				
N	30	59	15	44
Mean (SD)	60	14.6 (1.0)	3.4 (1.2)	92 (32)

N/A Not available

* Based on single studies

[a] Wouter et al. [24]; Din et al. [5]; Kouzelis et al. [12]; Kocher et al. [11]

Table 5 Postoperative weighted mean outcome measures by technique where available

Treatment	Postop Lysholm	Postop Tegner	Postop Hughston
Bioabsorbable pins only			
N	31	24	16
Mean (SD)	90.0 (8.6)	7.9 (1.9)	3.6 (0.5)
Bioabsorbable screws			
N	5	5	N/A
Mean (SD)*	87.8 (9.6)	5.8 (2.2)	N/A
Bone pegs only			
N	9	9	9
Mean (SD)*	80.2 (22.3)	4.2 (1.6)	3.3 (0.5)
Differential pitch screws and base drilling			
N	8	N/A	N/A
Mean (SD)*	100.0	N/A	N/A
Extra-articular drilling			
N	67	31	23
Mean (SD)	96.5 (7.0)	7.2 (1.7)	3.7 (0.5)
Transarticular drilling			
N	23	N/A	N/A
Mean (SD)	92.8 (10.0)	N/A	N/A
Osteochondral plugs			
N	N/A	N/A	10
Mean (SD)*	N/A	N/A	3.8 (0.4)
Combined treatments[a]			
N	27	24	12
Mean (SD)	85.5 (16.5)	7.4 (2.1)	3.7 (0.5)

N/A Not available

* Based on single studies

[a] Wouter et al. [24]; Din et al. [5]; Kouzelis et al. [12]; Kocher et al. [11]

Table 6 Postoperative healing by modality where available

Assessment modality	Percent healed
Radiographs	94.3
MRI	93.7
Arthroscopy	91.7
Roentgenogram	100
Overall	94.1

from 80.2 to 100 (Lysholm), 4.2 to 7.9 (Tegner) and 3.3 to 3.8 (Hughston). There were high correlations between the outcome scores by surgical technique. It was 50 % (5 studies) between postoperative Lysholm and Tegner, 68 % (4 studies) between Lysholm and Hughston and 31 % (4 studies) between Tegner and Hughston. Postoperative healing as assessed by a variety of modalities is illustrated in Table 6. Where reported, all modalities showed healing in most lesions.

Many authors described their surgical treatments based on stability of lesions, expressly indicating "stable" or "unstable" lesions, in addition to indicating imaging and arthroscopic classifications, while others simply reported lesions based on classifications. For lesions described as stable, surgical techniques included arthroscopic or open transarticular drilling, extra-articular drilling, transarticular drilling with bioabsorbable pin fixation, bone pegs and bioabsorbable screws (fully threaded and lag screws). For lesions described as unstable, surgical techniques included arthroscopic or open bioabsorbable pins, metal screws, bone pegs, transarticular drilling with bioabsorbable pin fixation, bioabsorbable screws, differential pitch screws, osteochondral plugs, differential pitch screw with extra-articular drilling and differential pitch screw with drilling the base of the lesion. Within a particular operative treatment group, there were often differences in devices, supplemental modalities employed and approaches. The most common techniques included transarticular drilling (41 % of lesions), extra-articular drilling (29 %), bioabsorbable pins (7 %), bone pegs (4 %) and bioabsorbable lag screws (3 %). Surgeon experience was not expressly stated in most studies.

Discussion

Given the potential sequelae of lesions that are unstable or have failed non-operative treatment, namely pain, limitations of daily or sports activities, mechanical symptoms and arthrosis, it is important to understand the operative options in current practice. The goal of this review is to identify the surgical techniques used to treat OCD lesions in patients 18 years of age or younger and assess their outcomes. In addition, consistency of reported clinical and radiographic outcomes was assessed.

The most important findings of the present study were that the surgical techniques described were numerous for both stable and unstable lesions but that the vast majority of lesions were judged healed postoperatively (94.1 %), despite the diversity of techniques employed. This diversity likely stems from the fact that no particular techniques have been shown to be superior through high-quality studies. Surgical treatment of stable lesions demonstrated more consistency, with transarticular and extra-articular drilling being most common. These techniques have been effectively used for decades and are relatively straightforward, likely explaining their prevalence. Unstable lesions were treated with an even greater variety of techniques. The majority of techniques each represented less than 5 % of treated lesions. A variety of new devices have become available for surgical treatment of OCD. The interest in assessing the effectiveness of such devices as well as the lack of clear superiority of any one technique likely also contributes to the diversity of techniques.

This review presents several strengths. It is the first systematic review of surgical techniques for OCD lesions of the knee in paediatric patients. Techniques were listed based on lesion stability, and outcome measures were determined by technique where available. Analysis of functional outcomes can provide a guide for predicting possible outcomes in similar patients.

This systematic review, however, suffers from major limitations, and the findings should be interpreted with caution. All studies are case series lacking a comparison group, and the majority include very small sample sizes. Most of the reported means for baseline characteristics and outcome scores are based on single studies with small sizes. Preoperative and postoperative characterization of lesions, as well as functional outcome measures, was not reported in a consistent and standardized manner, limiting commentary on the superiority of some techniques over others. While the Lysholm, Tegner and Hughston outcome measures were used most frequently, none of these were used consistently enough to allow for a robust broader analysis and most preoperative scores were not reported. Moreover, another limitation is reporting weighted mean Tegner scores rather than weighted median. The Tegner score is an ordinal variable, and reporting median as measure of central tendency is more accurate than mean. Three of 5 studies reported mean and two reported raw data. Given this, the calculation of weighted mean with standard deviation is appropriate. Reporting of healing as interpreted through radiographic/MRI and arthroscopic evaluation was even less consistent. Postoperative healing was mostly reported using descriptive radiographic, MRI and arthroscopic evaluation, with terms such as healed, united and incorporation, as opposed to standardized classifications. Heterogeneity of multiple aspects of the reviewed papers was prevalent.

In future studies, a prospective and methodologically sound registry with rigorous reporting of preoperative and postoperative outcome measures should be undertaken using one or two of the most widely accepted functional outcome measures such as the Lysholm and Tegner. Classifications of lesions should be reported preoperatively and postoperatively based on one or two standard imaging classification systems, particularly in the place of non-standardized descriptive evaluations. The availability of complete and consistent demographics, as well as functional and imaging outcomes, both preoperatively and postoperatively, will allow for a more rigorous analysis of the reported data, and lead to significantly higher quality of evidence on which to base treatment decisions. Ultimately, there is a need for randomized controlled trials to evaluate the best surgical treatments for OCD.

Conclusions

This review found that stable OCD lesions of the knee in a paediatric population are most commonly treated with transarticular drilling, while unstable lesions are most commonly treated with bioabsorbable pin fixation. Preoperative classification of OCD lesions was very inconsistent among the studies reviewed, with a variety of common radiographic, MRI and arthroscopic classifications used. Postoperative classification of healing was also inconsistent with mostly subjective assessment based on radiographs or MRI. Functional outcomes were most commonly reported with postoperative Lysholm, Tegner or Hughston scores. Although the included studies were of high quality based on Yang scores, all were level 4 evidence with inherent limitations. A broader attempt to draw conclusions highlighted a number of shortcomings, including reporting quality. The key findings were that the vast majority of lesions healed postoperatively, regardless of technique, and that high-quality trials, including randomized controlled trials, are required to more appropriately compare the clinical effectiveness of techniques.

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Conflict of interest There are no possible conflicts of interest associated with this manuscript.

Appendix: Search strategy

(Osteochondritis or osteochondriti*.mp or ocd.mp or Joint Loose Bodies or loose bod*.mp) and (Knee or knee*.mp Knee Injuries or knee injur*.mp or Knee Joint patellofemoral.mp femoropatellar.mp or tibiofemoral.mp or femorotibial.mp or Femur or femur*.mp or Patella or patella*.mp)—limiting to [English language and humans and year = "2000–Current" and "all child (0–18 years)"] and excluding review articles. EMBASE was searched for (osteochondritis or osteochondritis dissecans or osteochondriti*.mp or ocd.mp or joint destruction or loose bod*.mp) and (knee or knee injury or knee*.mp or patellofemoral.mp or femoropatellar.mp or tibiofemoral.mp or femorotibial.mp or femur*.mp or femur or patella or patella*.mp)—limiting to [human and English language and year = "2000–Current" and (infant or child or preschool child < 1–6 years > or school child < 7–12 years > or adolescent < 13–17 years >)] and excluding review articles.

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