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COMBINED UNICOMPARTMENTAL KNEE ARTHROPLASTY AND ACL RECONSTRUCTION: A SYSTEMATIC REVIEW

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ABSTRACT – *Objective:* Unicompartmental knee arthroplasty (UKA) has shown good results in patients affected by isolated tibio-femoral osteoarthritis (OA). It is assumed that in active patients affected by medial OA and concomitant ACL instability a combined surgery of UKA and ACL reconstruction (ACLR) could ensure the best results. Conversely, whilst few studies identified ACL deficiency as a relative contraindication for UKA, implant failure resulted in up to 16% of cases not undergone ACLR.

Materials and Methods: A literature search was carried out on the PubMed, EMBASE, Scopus and PEDro databases on June 10th, 2022. A study was defined as eligible whenever the following inclusion criteria were met: content concerning combined UKA and ACLR in patients with isolated tibio-femoral OA and ACL-deficient knees; reported patient's clinical and/or functional outcomes; English language; date of publication between 1990 and 2021. The Modified Coleman Methodology Score (MCMS) was used for the methodological quality assessment.

Results: A total of 11 studies were included. The average MCMS was 52.4. In all papers included there was an improvement in both clinical and subjective outcomes from baseline to post-intervention. Clinical outcomes of the combined procedure resulted to be similar to those of patients with intact ACL undergoing UKA only. Implant survival rate resulted to be comparable to that of patients with intact ACL and higher compared to that of patients with ACL deficiency undergoing UKA alone.

Conclusions: Combined UKA and ACLR is a viable option to manage knee pain and instability in young and active patients with medial compartment OA and ACL deficiency.

KEYWORDS: Medial knee osteoarthritis, Anterior cruciate ligament injury, Unicompartmental knee arthroplasty, ACL reconstruction, Combined UKA, CL reconstruction.

INTRODUCTION

Medial osteoarthritis (OA) in young patients is commonly a consequence of anterior cruciate ligament weakening or damages[1], which result in joint failure and instability[2]. However, cartilaginous structures of the lateral compartment are generally preserved and shortening of the medial collateral ligament is typically absent[3,4].

The currently available techniques for medial OA management in patients with ACL-deficient knee are high tibial osteotomy (HTO) with or without ACL reconstruction (ACLR), unicompartmental knee arthroplasty (UKA) alone or in association with ACLR and total knee arthroplasty (TKA).

Although a damaged ACL was considered to be a contraindication for HTO surgery[5], HTO with concomitant ACLR is nowadays considered to be a safe and effective procedure in young patients with medial OA symptomatology and ACL deficiency, allowing to restore correct knee alignment and stability and implying very low revision and complications rates[6,7]. Yet, when compared to UKA associated with ACLR, complications rate of HTO with concomitant ACLR appears to be higher[3,8].

In elderly individuals with severe OA and ACL damage, TKA is still the preferred surgical approach[9,10] as well as in the case in which pain is the main complaint[11]. However, TKA is less indicated in young and active patients with isolated knee OA and ACL damage, as they could benefit more from HTO or UKA[10].

In this specific group of patients, UKA is the preferred approach[12], since it ensures better and lasting knee functionality, yet securing bone preservation and reducing intra-operative bleeding and complications[3]. For this reason, it is assumed that the combination of UKA and ACLR in young individuals could ensure the best results in patients affected by medial OA and concomitant functional ACL instability[12]. However, inflammatory arthritis, ligamentous laxity, previous meniscectomies or knee malalignment could represent contraindications to UKA[13].

In contrast to the aforementioned considerations, whilst few studies[14] examining concomitant UKA and ACLR surgery identified ACL deficiency as a relative contraindication to UKA, implant failure was observed in up to 16% of cases not undergone ACLR, as a consequence antero-posterior and rotational instability due to the absence of an intact ACL[15-17].

In order to put up with these conflicting visions, the present review aims at identifying highlights, limitations and possible complications of UKA associated to ACLR by systematically analyzing all the available studies concerning the combined procedure.

MATERIALS AND METHODS

A literature search was carried out on the PubMed, EMBASE, Scopus and PEDro databases, on June 10th, 2022, using the following keywords combined together to achieve maximum search strategy sensitivity: “unicompartmental”, “unicondylar”, “partial” in association with “knee replacement”, “knee arthroplasty” and “ACL injury”, “ACL rupture”, “ACL lesion”, “anterior cruciate ligament reconstruction”, “ACL reconstruction” and “ligament reconstruction”.

All the collected papers were screened by title and abstract, according to inclusion and exclusion criteria. Inclusion criteria comprised: (1) studies dealing with combined unicompartmental knee arthroplasty and anterior cruciate ligament reconstruction in patients with isolated tibio-femoral OA and ACL-deficient knees; (2) studies in which patients' clinical and/or functional outcomes were reported; (3) studies written in the English language; and (4) studies published from 1990 to 2022.

Exclusion criteria comprised: (1) studies not dealing with combined unicompartmental knee arthroplasty and anterior cruciate ligament reconstruction in patients with isolated tibio-femoral OA and ACL-deficient knees; (2) studies in which patients' clinical and/or functional outcomes were not clearly reported; and (3) studies written in languages other than English. We further excluded all duplicate articles, articles from non-peer-reviewed journals or articles lacking access to the full text.

Conference presentations, narrative reviews, editorials and expert opinions were also excluded. A PRISMA flowchart of the selection and screening method is provided in Figure 1.

Two investigators individually extracted the relevant data. The following data were extracted from each included study: author, year of publication, type of study, number of patients enrolled, sex, mean age and mean follow-up, scoring system used, pre-operative and post-operative scores. Discrepancies between the two reviewers were resolved by discussion and consensus, and the final results were reviewed by the senior investigators. To assess the quality of the studies, the Coleman Methodology Score (CMS) was used, which assessed methodology with 10 criteria, giving a total score between 0 and 100. A score of 100 indicated that the study largely avoided chance, various biases, and confounding fac-

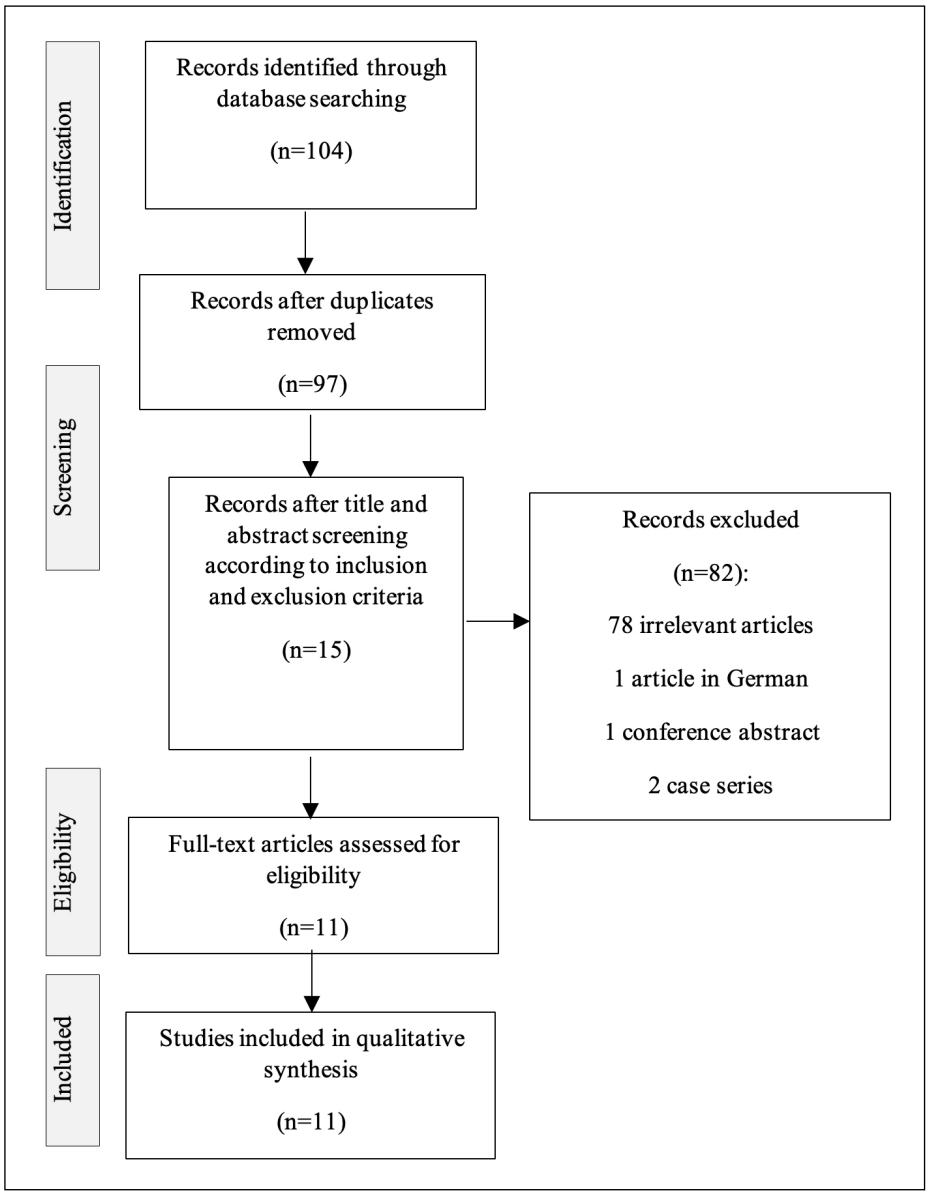

Figure 1. Flowchart of selected articles.

tors. The Coleman criteria were modified to make them reproducible and relevant for this systematic review and are shown in Table 1. Two investigators separately evaluated each article using the Modified Coleman Methodology Score (MCMS). Any discrepancy was discussed with and resolved by the senior investigator, who made the final judgment.

RESULTS

Identification of Studies

A total of 97 related articles were identified through databases searching. After title and abstract screening according to inclusion and exclusion criteria, 15 studies were included. As shown in Figure 1, 4 articles were excluded after full-text screening and, ultimately, a total of 11 studies[4,9,12,18-25], 7 prospectives[9,12,18-21,25] and 4 retrospectives[4,22-24], published from July 2006 to November 2020, dealing with combined unicompartmental knee arthroplasty and anterior cruciate ligament reconstruction in patients with isolated tibio-femoral OA and ACL-deficient knee were included in the present study. A synopsis of all papers included in the present systematic review is shown in Table 2.

Table 1. Modified Coleman Methodology Score.

Part A: Only one score to be given for each of the 7 sections	
1. Study size: number of patients	
<30	0
30-50	4
51-100	7
>100	10
2. Mean follow-up	
<12 months	0
12-36 months	4
37-60 months	7
>61 months	10
3. Surgical approach	
Different approach used and outcome not reported separately	0
Different approaches used and outcome reported separately	7
Single approach used	10
4. Type of study	
Retrospective cohort study	0
Prospective cohort study	10
Randomized controlled trial	15
5. Description of diagnosis	
Described without percentage specified	0
Described with percentage specified	5
6. Descriptions of surgical techniques	
Inadequate (not stated, unclear)	0
Fair (technique only stated)	5
Adequate (technique stated, details of surgical procedure given)	10
7. Description of postoperative rehabilitation	
Described	5
Non described	10
Part B: Scores may be given for each option in each of the 3 sections if applicable	
1. Outcome criteria	
Outcome measures clearly defined	2
Timing of outcome assessment clearly stated	2
Use of outcome criteria that has reported reliability	3
General health measure included	3
2. Procedure of assessing outcomes	
Participants recruited	5
Investigator independent surgeon	4
Written assessment	3
Completion of assessment by patients themselves with minimal investigator assistance	33
3. Description of subject selection process	
Selection criteria reported unbiased	5
Recruitment rate reported	
>90%	5
<90%	0

Table 2. Main features of included studies.

Study, year	Type of study	Number of patients	M/F	Mean Age (years)	Mean follow-up (months)
Pandit et al[9], 2006	PS	15	13/2	49.8	33.6
Pandit et al[20], 2008	PS	10	10/0	49.1	3.3 (3-5)
Krishnan et al[19], 2009	RS	9	5/4	56	24
Weston-Simons et al[4], 2012	PS	51	40/11	51	60
Tinius et al[23], 2012	PS	27	11/16	44	53
Ventura et al[24], 2017	PS	14	9/5	55	26.7
Tian et al[22], 2016	PS	28	18/10	50.5	52
Iriberri et al[18], 2018	RS	8	5/3	52	14.06
Kennedy et al[12], 2019	PS	75	59/16	52.6 (36-71)	6.04
Ventura et al[25], 2019	RS	14	8/4	54	7.8 (6-10)
Tecame et al[21], 2019	RS	24	20/4	47.8, 48.4	53±8.3 42±6.7

PS: prospective study; RS: retrospective study.

Studies Characteristics

Eleven studies[4,9,12,18-25] involving a total of 275 patients affected by isolated tibio-femoral OA and ACL-deficient knee were included in this review. The mean age was 52 years old. The average MCMS was 52.4 (44-62). The average total MCMS and the average MCMS for each criterion are given in Table 3.

Of the 11 studies, 4 were conducted in United Kingdom[4,9,12,20], 3 in Italy[21,24,25], 1 in Germany[23], 1 in Spain[18], 1 in Australia[19], 1 in China[22].

In the retrospective study of Iriberri et al[18], a group 8 patients underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 14.6 years.

In the prospective study of Kennedy et al[12], a group of 76 patients underwent one-stage (58 patients) or two-stage (18 patients) medial UKA and ACL reconstruction. The mean follow-up time was 6 years[12].

In the retrospective study of Krishnan et al[19], 6 patients underwent one-stage medial UKA and ACL reconstruction, 1 patient underwent one-stage lateral UKA and ACL reconstruction, 2 patients underwent one-stage bilateral UKA and ACL reconstruction. The mean follow-up time was 2 years[19].

In the prospective study of Pandit et al[9], a group of 15 patients (ACLR group) underwent one-stage (4 patients) or two-stage (11 patients) medial UKA and ACL reconstruction. The mean follow-up time was 2.8 years. They also compared the ACLR group with a group of 15 patients with medial OA and an intact anterior cruciate ligament who underwent medial UKA only (ACLI group)[9].

In the prospective study of Pandit et al[20], a group of 10 patients (ACLR group) underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 3.3 years. They also compared the ACLR group with a group of 10 patients with medial OA and an intact anterior cruciate ligament who underwent medial UKA only (ACLI group)[20].

In the retrospective study of Tecame et al[21], a group of 24 patients underwent one-stage medial UKA and ACL reconstruction. Nine patients received a mobile bearing UKA (Group 1) and fifteen a fixed-bearing one (Group 2). The mean follow-up time was 4.4 years for Group 1 and 3.5 years for Group 2[21].

In the prospective study of Tian et al[22], a group of 28 patients underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 4.3 years[22].

In the prospective study of Tinius et al[23], a group of 27 patients underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 4.2 years[23].

In the prospective study of Ventura et al[24], a group of 14 patients underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 2.2 years[24].

In the retrospective study of Ventura et al[25], a group of 12 patients (over a total of 14 patients enrolled) underwent one-stage medial UKA and ACL reconstruction. The mean follow-up time was 7.8 years[25].

Table 3. Modified Coleman Methodology Score.

Study, year	Study size	Mean follow-up	Surgical approach	Type of study	Description of diagnosis	Description of surgical technique	Description of post-operative rehabilitation	Outcome criteria	Procedure of assessing outcome	Description of subject selection process	Coleman Score
Pandit et al[9], 2006	0	4	7	10	0	10	0	7	8	5	**51**
Pandit et al[20], 2008	0	7	10	10	0	5	0	7	8	5	**52**
Krishnan et al[19], 2009	0	4	10	0	0	10	5	7	8	5	**49**
Weston-Simons et al[4], 2012	7	7	7	10	0	5	0	7	8	5	**56**
Tinius et al[23], 2012	0	7	10	10	0	10	0	7	8	5	**57**
Ventura et al[24], 2017	0	4	10	10	0	10	5	7	8	5	**59**
Tian et al[22], 2016	0	7	10	10	0	10	5	7	8	5	**62**
Iriberri et al[18], 2018	0	4	10	0	0	10	0	7	8	5	**44**
Kennedy et al[12], 2019	7	0	7	10	0	5	0	7	8	5	**49**
Ventura et al[25], 2019	0	0	10	0	0	10	5	7	8	5	**45**
Tecame et al[21], 2019	0	7	10	0	0	10	5	7	8	5	**52**

Average Coleman Score: **52.4**

In the prospective study of Weston-Simons et al[4], a group of 51 patients underwent one-stage (33 patients) or two-stage (18 patients) medial UKA and ACL reconstruction. The mean follow-up time was 4.2 years[4].

Pre-Operative Examination

Patients evaluated in the various studies were all affected by isolated tibio-femoral OA in ACL-deficient knees. Knee OA was evaluated by radiological assessments in the vast majority of the studies included[9,18-25].

ACL deficiency was evaluated clinically and in six studies with magnetic resonance imaging[9,18,21,23-25].

Functional Outcome

Different clinical scores were used for baseline and follow-up assessments: Oxford Knee score (OKS), Tegner score, Functional Knee Society score (FKS), Knee Society score (KSS), Western Ontario and McMaster Universities Arthritis Index (WOMAC), American Knee Society Score Objective (AKSS-O), American Knee Society Score Functional (AKSS-F), Knee Osteoarthritis Outcome score (KOOS) and Visual Analogue scale (VAS). A summary of the clinical score is shown in Table 4.

Subgroup Analysis

In two studies[4,12] in which patients underwent either one-stage or two-stage medial UKA and ACL reconstruction, no statistically significant difference in clinical scores has been found between groups.

In one study[9], the group of patients who underwent combined medial UKA and ACL reconstruction registered higher clinical scores compared to the group of patients with intact ACL who underwent medial UKA alone. No subgroup analysis between patients who underwent either one-stage or two-stage surgery has been carried out.

In one following study[21] of the same author, no statistically significant differences were observed between the group who received medial UKA and ACL reconstruction and the group who received medial UKA alone[20].

One study[4] demonstrated that, concerning the type of implant, no significant difference was observed in WOMAC and KSS comparing the use of mobile-bearing UKA or fixed-bearing UKA.

One study evaluated post-operative scores between patients aged <50 years and those aged >50 years and found no significant difference between the two groups.

In another study[12], authors evaluated OKS scores between patients younger than 55 and patients older than 55 and reported a median OKS two points lower in the group of younger patients, but a greater increase in OKS compared to the subgroup of older patients.

Implant Survival

Two studies[4,12] have evaluated implant survival rates. In one study implant survival rate at five years was 92.7% and at eight years was 92.7%[4]. In the second study it was estimated that the five-, ten- and fifteen-years Kaplan-Meier survival rates were respectively 97.0%, 92.3% and 92.3%[12].

Complications

Complications reported by various studies[4,22] included tibial inlay dislocation, symptomatic lateral compartmental osteoarthritis[4], deep-vein thrombosis and retropatellar pain due to scar adhesions[23], and periprosthetic joint infections requiring revision to TKA[4,9].

Table 4. Summary clinical scores.

Study, year	Scoring system	Pre-operative score	Post-operative score
Pandit et al[9], 2006	OKS	29 (17-36)	46 (37-48)
	Tegner	1.6 (1-3)	3.8 (3-6)
	AKSS-O	55 (25-83)	99 (95-100)
	AKSS-F	85 (65-90)	96 (85-100)
Pandit et al[20], 2008	OKS	28 (7.2)	45 (2.8)
	Tegner	1.6 (0.8)	3.8 (1.0)
	AKSS-O	55 (16.2)	99 (2)
	AKSS-F	85 (9)	96 (8)
Krishnan et al[19], 2009	OKS	23.5 (20-58)	11 (10-12)
	KSS	135 (64-167)	196 (190-200)
	WOMAC	45 (35-52)	24 (21-27)
Weston-Simons et al[4], 2012	OKS	28 (16-46)	41 (17-48)
	Tegner	2.5 (1-5)	3.5 (1-5)
	AKSS-O	40 (25-80)	75 (25-95)
	AKSS-F	82 (45-100)	95 (45-100)
Tinius et al[23], 2012	KSS	77.1 (±11.6)	166.03 (±12.1)
	FKS	38.7 (± 8.8)	82.7 (±8.2)
Ventura et al[24], 2017	OKS	29 (10.2)	43.2 (9.5)
	WOMAC	72.1 (12.5)	85.8 (8.7)
	Tegner	2 (1-3)	3 (2-4)
	AKSS-O	45 (12.9)	77 (13)
	AKSS-F	80 (14.2)	90 (15)
	KOOS	62.7 (8.4)	81 (10.2)
Tian et al[22], 2016	OKS	31 (7.1)	43 (4.2)
	Tegner	4.4 (1.2)	5.3 (0.8)
	FKS	63.7 (6.5)	86.9 (5.3)
	KSS	60.4 (7.1)	84.5 (6.3)
Iriberri et al[18], 2018	KSS	94 (62-165)	154 (102-200)
	WOMAC	59 (3-81)	26 (1-52)
	VAS	8 (6-10)	3 (0-7)
Kennedy et al[12], 2019	OKS	29.1 (8)	45 (41-47)
	Tegner	2.9 (1)	3.6 (2)
Ventura et al[25], 2019	OKS	28.8 (10.1)	42.4 (8.9)
	WOMAC	71.9 (11.5)	84.9 (9.3)
	AKSS-O	45 (12.9)	75 (13.5)
	AKSS-F	80 (14.2)	88 (16.2)
	KSS	62.4 (8.1)	80.2 (11.7)
Tecame et al[21], 2019	KSS	71.2 (±7.4)	86.2 (±6.2)
	WOMAC	55.78 (±7.6)	79.3 (±7.3)

OKS: Oxford Knee Score, AKSS-O: American Knee Society Score Objective, AKSS-F: American Knee Society Score Functional, KSS: Knee Society Score, WOMAC: Western Ontario and McMaster Universities Arthritis Index, FKS: Functional Knee Society score, KOOS: Knee Osteoarthritis Outcome Score, VAS: Visual Analogue Scale.

DISCUSSION

The main finding of this review is that combined UKA and ACL reconstruction is a valid technique to address medial compartment OA in active patients with ACL-deficient knee since it implies fewer complications and more advantages compared to the other surgical options currently available. In all papers included in this review, an improvement from baseline to post-operative clinical and subjective outcomes was observed. As demonstrated by Pandit et al[9,20], clinical outcomes of the combined procedure are similar to those of patients with intact ACL undergoing only UKA or even higher[9,20]. Furthermore, by comparing implant survival rates reported in two of the studies[4,12,26] included in our review with implant survival rates of UKA in patients with intact ACL reported in the literature, we can state that implant survival in patients undergoing the combined procedure is comparable to that of patients with intact ACL undergoing UKA alone and, as demonstrated by the study of Goodfellow et al[16], it is significantly higher compared to patients with ACL deficiency undergoing UKA alone[15,16].

Another fundamental aspect highlighted by this review is that among all the factors analyzed in the different studies, none of them showed significant impact on the clinical outcomes nor on the survival rate of the implant. Indeed, as demonstrated by Weston-Simons et al[4] and Kennedy et al[12], no statistically significant differences in terms of clinical outcomes were found between patients who underwent one-stage surgery and patients who underwent two-stage surgery[4,12]. Moreover, as demonstrated by the same authors, no significant differences in clinical scores or in implant survival rates was observed between the two subgroups of patients, divided by age cut-off of 50 or 55 years, probably due to the fact that even the group of older patients could represent an active population, considering their willingness to undergo ACL reconstruction[4,12]. Furthermore, the choice of either fixed-bearing or mobile-bearing implant design, as demonstrated by Tecame et al[21], did not affect the medium-term clinical and radiological outcomes[21] In light of what has been explained above, this review confirms that the fundamental aspect to be taken into consideration in order to have good outcomes in this combined procedure is the adequate selection of candidates according to their level of physical activity and their lifestyle: whilst patients with less active habits may benefit from arthroplasty alone, patients with higher functional needs could benefit more from combined UKA and ACL reconstruction[3,18].

Limitations

Two limitations of this review are the heterogeneity of outcome measurements adopted in the different studies, which prevented us from performing a quantitative analysis of the collected data, and the assumption made by the Modified Coleman Methodology Score.

Indeed, this is the only review that used the Modified Coleman Methodology Score to assess the methodological quality of the included studies. Methodological quality results were medium to low, nevertheless they must be interpreted in light of some considerations.

The low score obtained in the “study size” category is influenced by the fact that the number of patients undergoing these types of surgeries is necessarily low considering that only highly skilled surgeons in both joint reconstruction and sports medicine are able to perform complex surgeries like this one.

The low score obtained in the “study type” category is influenced by the fact that an RCT is probably not feasible due to ethical and regulatory reasons.

The low score obtained in the “description of diagnosis” category has to be considered in light of each study describing the degree of cartilage damage and the status of ACL, but without defining any of the two variables in percentages.

CONCLUSIONS

Simultaneous or staged UKA and ACL reconstruction seems to be a viable option to manage knee pain and instability in active patients with medial compartment osteoarthritis and ACL deficiency. However, considering the heterogeneity of outcome measurements adopted in the literature included and the results of the Modified Coleman Methodology Score, further research is needed to validate the findings of this review.

Conflicts of Interest:
Each author certifies that he has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Founding:
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Ethics Approval and Informed Consent:
Not applicable.

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