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REVIEW

The clinical outcome of chondrolabral-preserving arthroscopic acetabuloplasty for pincer- or mixed-type femoroacetabular impingement: A systematic review

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Abstract
While preservation and repair of the acetabular labrum are increasingly being recognized as important goals in hip arthroscopy, controversies still exist regarding the clinical outcome of arthroscopic acetabuloplasty with chondrolabral preservation. A systematic review was conducted and implemented by two independent reviewers, who used the MEDLINE/PubMed database and the Cochrane Database of Systematic Reviews for their search. These databases were queried with the terms "arthroscopic acetabuloplasty" and "chondrolabral preservation" and "arthroscopic acetabular recession." From the 55 initial studies the reviewers finally chose and assessed five clinical studies which were eligible to their inclusion–exclusion criteria. The reviewed studies included in total 444 patients, mainly young, between 30 and 40 years old. The follow-up evaluation varied between 24 and 41 months, while all studies utilized at least a 24-month final end-point assessment. All five studies illustrated improved outcome with the use of chondrolabral preservation acetabuloplasty without labral detachment. The rate of complications was very low. The different techniques of arthroscopic acetabuloplasty combined with chondrolabral preservation illustrated encouraging results in patients suffering from pincer-type or mixed-type FAI. However, the available clinical evidence was limited and insufficient to establish any superiority of these techniques over the traditional labral detachment and sequential reattachment. In relation to the optimal treatment of FAI without isolated CAM, further research of higher quality is recommended to be conducted in order to lead to definitive conclusions.

Keywords Chondrolabral preservation · Pincer impingement · Labral detachment · Arthroscopic acetabuloplasty · Over the top · Systematic review

Introduction

Hip impingement between the rim of the acetabulum and the proximal femur is a clinical identity which has been reported as a substantial cause of pain and restriction in range of motion (RoM) [1]. Smith-Petersen was the first one to suggest the surgical removal of the anterior wall of the acetabulum as the method of treatment for hip impingement [2]. He supported that the sacrifice of a small portion of the acetabulum would lead to restoration of RoM back to normal [2].

In the past two decades, there were significant improvements in the diagnosis and management of this condition, which led to improved patient outcomes [3]. Morphological and spatial abnormalities of the proximal femur and acetabulum have been recognized as causes of femoroacetabular impingement [3]. Femoroacetabular impingement (FAI) has been identified as a cause of hip pain, labral and chondral pathology, and decreased athletic performance [4]. Based on clinical experience, some authors proposed femoroacetabular impingement as a mechanism for the development of early osteoarthritis in most non-dysplastic hips [5–7].

Traditionally, FAI has been divided into three types: CAM impingement, pincer impingement and mixed type (coexistence of CAM and pincer impingement). CAM-type

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impingement is the result of abnormal femur morphology typically defined by a decrease in anterior femoral head neck offset or an aspheric femoral head, while pincer impingement arises due to morphological variation on the acetabular side with focal or global overcoverage of the femoral head [8]. Regarding the pincer type or mixed type of femoroacetabular impingement (combined CAM and pincer), different arthroscopic approaches have been developed, either with or without repair or reconstruction of the acetabular labrum [9–13]. Labral detachment before pincer resection allows for excellent visualization of anterosuperior pincer lesions, which—in combination with fluoroscopic imaging—increases the likelihood of an adequate resection [14]. Surgeons who perform labral detachment in order to resect part of the acetabular rim for the treatment of femoroacetabular impingement without isolated CAM reattach the labrum with the use of suture anchors [15]. The current evidence suggests that this technique leads to incomplete or focal healing at the chondrolabral junction [16].

An alternative arthroscopic technique without labral detachment was described by different authors without including clinical outcomes [17–19]. This technique, which is also called "over the top," leaves the labrum in situ without any labral detachment and subsequent reattachment. If the chondrolabral junction remains intact with a "viewable" overhanging rim from above, a burr can be utilized to resect the bone excess without detaching the labrum or penetrating the junction. Variations of this procedure with subperiosteal elevation of the chondrolabral complex have also been described [20].

Recently, a number of clinical trials examined the efficacy of the just above-mentioned, chondrolabral-preserving techniques in the treatment of femoroacetabular impingement without isolated CAM [21]. While preservation and repair of the acetabular labrum are increasingly being recognized as important goals in hip arthroscopy, no review of the literature has been published yet in relation to the clinical outcome of arthroscopic acetabuloplasty with chondrolabral preservation in femoroacetabular impingement without isolated CAM.

The aim of this systematic review was to answer the question whether arthroscopic acetabuloplasty with chondrolabral preservation is an effective treatment for patients suffering from pincer- or mixed-type femoroacetabular impingement. A second question to be answered through this review was: What is the quality of the evidence of the already published studies which investigate the use of arthroscopic acetabuloplasty without labral detachment for the aforementioned patients?

Materials and methods

Two reviewers independently conducted the search in a systematic way (according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) using the MEDLINE/PubMed database and the Cochrane Database of Systematic Reviews [22]). These databases were queried with the terms "arthroscopic acetabuloplasty" and "chondrolabral preservation" and "arthroscopic acetabular recession." To maximize the search, backward chaining of reference lists from retrieved papers was also undertaken. A preliminary assessment of only the titles and abstracts of the search results was initially performed. The second stage involved a careful review of the full-text publications.

Inclusion criteria were studies investigating these types of arthroscopic acetabuloplasty (or osteoplasty), which were combined with chondrolabral preservation in patients suffering from pincer type or mixed type of femoroacetabular impingement (without isolated CAM). The clinical trials included should have contained at least a 24-month follow-up evaluation, while all eligible studies must have been written in English. Furthermore, they should have been published until December 15, 2017 (end of our search), as full-text articles.

We used the following exclusion criteria: studies dealing with isolated CAM impingement, preclinical trials, literature reviews, editorial comments, corrigendums, abstracts, studies with less than 24-month follow-up, trials referring to labral repair with labral detachment and studies exclusively dealing with labral debridement/excision. We also planned to exclude articles not written in English as well as all those papers which were published after December 25, 2017.

The quality of the evidence was classified using the US Preventive Services Task Force system for ranking level of evidence.

Differences between reviewers were discussed until agreement was achieved. They independently extracted data from each study and assessed variable reporting of outcome data. Descriptive statistics were calculated for each study and parameters analyzed. The methodological quality of each study and the different types of detected bias were assessed independently by each reviewer, and then, they were combined synthetically. Selective reporting bias like publication bias was not included in the assessment. The primary outcome measure was the postoperative improvement of the clinical scores used in comparison with the preoperative scores per study. Secondary outcome was the reoperations' rate per study.

Results

From the 55 initial studies, we finally chose and assessed five clinical studies, which were eligible to our inclusion–exclusion criteria. We excluded all irrelevant studies (29), systematic reviews of the literature (10) (but not relevant to our review), trials referring to labral repair with labral detachment (4), cadaveric studies (2), studies exclusively dealing with labral debridement/excision (1) and a corrigendum (1). A summary flowchart of our literature search according to PRISMA guidelines can be found in Fig. 1.

This review dealt with one randomized controlled study level I (20%) [23], two prospective studies level III (40%) [24, 25], one retrospective case series level IV (20%) [26] and one technical note (20%) (level V) including a report about a retrospective case series [21] (Table 1). Only two out of the five studies compared acetabuloplasty without labral detachment with a second group of patients who underwent acetabuloplasty with labral detachment (40%) [23, 25].

The aforementioned studies included 444 patients in total. General demographic information, including age and gender, were reported in 60% and 80% of the studies, respectively. The vast majority of patients included in this review were young (mean age: 33.3 years), between 30 and 40 years old (Table 2). The follow-up evaluation ranged from 24 to 41 months (mean follow-up: 28.9 months), while 20% of the studies (one study) did not report any mean follow-up. All

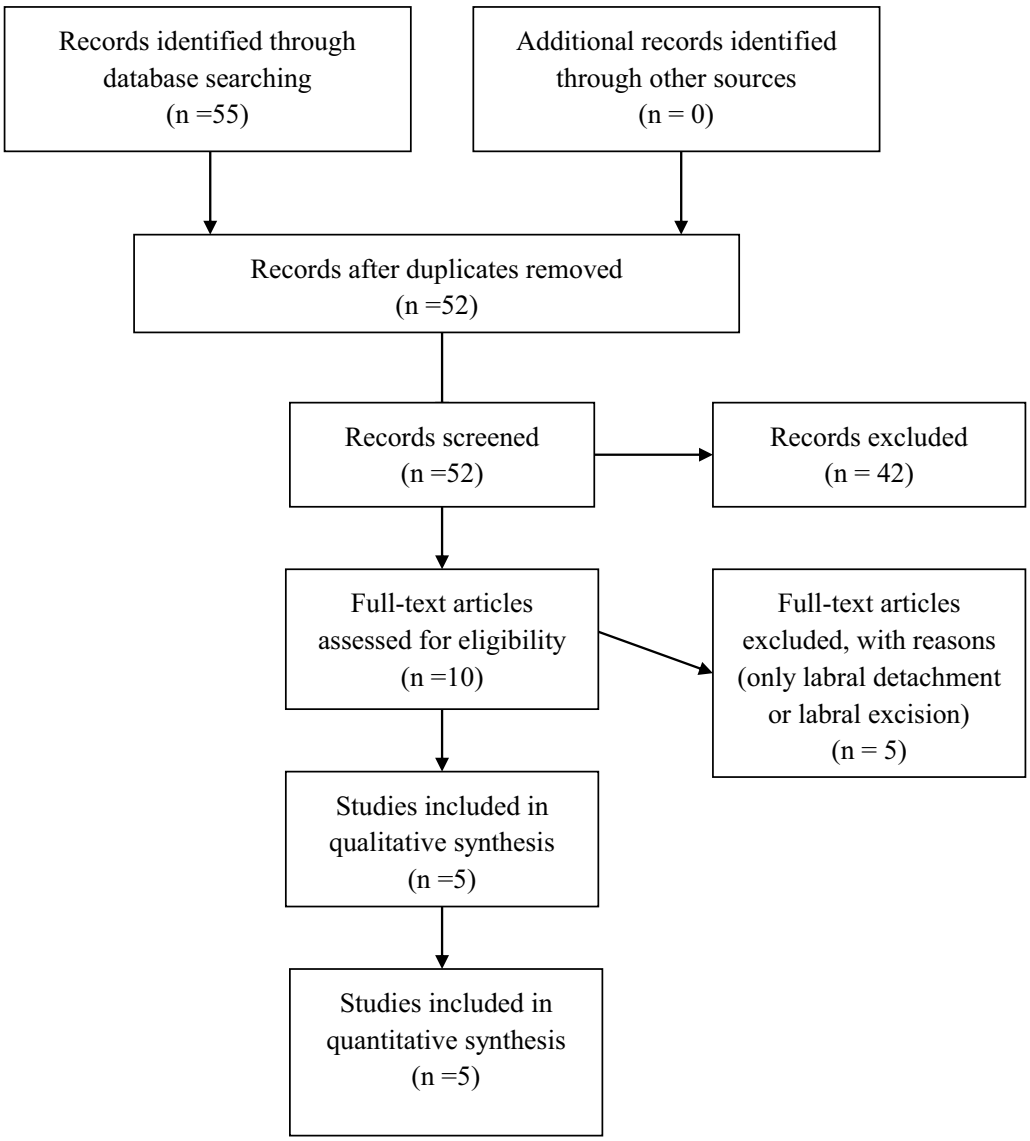

Fig. 1 PRISMA 2009 flow diagram

studies (100%) utilized at least a 24-month final end-point assessment.

Clinical quantitative variables were reported in 80% of the studies. All studies dealt with patients suffering from either pincer or mixed type of femoroacetabular impingement (combined CAM and pincer), whereas only 40% of these trials reported the exact number of patients per impingement type. So, the percentage of patients who had mixed-type impingement was 64.9%, while the rest 35.1% were diagnosed with a pure pincer type of femoroacetabular impingement.

The most commonly used clinical score was the visual analogue scale (VAS) with a 60% rate among studies, whereas modified Harris Hip Score (mHHS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Hip Outcome Score (HOS) were deployed equally in 40%, 40% and 40%, respectively. All five studies illustrated improved outcome (80% with statistical significance and 20% with no statistical report) with the use of chondrolabral preservation acetabuloplasty without labral detachment (Table 3). As for the

Table 1 Type of study, level of evidence, follow-up and type of operation(s)

Author(s)	Type of study	Level of evidence	Type of operation(s)	Follow-up
Comba et al. [26]	Retrospective case series	IV	Acetabuloplasty without labral detachment	32 months (27–38)
Ilizalitturi et al. [24]	Prospective non-comparative study	III	Acetabuloplasty without labral detachment	41 months (12–62)
Redmond et al. [25]	Prospective comparative study	III	Acetabuloplasty with versus without labral detachment	24 months
Krych et al. [23]	Prospective randomized study	I	Acetabuloplasty with versus without labral detachment	32 months (12–48)
Syed et al. [21]	Retrospective case series as part of a technical note article	V	Chondrolabral preservation with subperiosteal labrum/chondral elevation	24 months minimum

Table 2 Number of patients per study, sex, mean age and type of lesion

Author(s)	Number of patients	Sex	Mean age (years)	Type of lesion
Comba et al. [26]	44	36 males 8 females	N/A	4 pincer type, 40 mixed type
Ilizalitturi et al. [24]	50	20 males 30 females	30.5	29 pincer type, 21 mixed type
Redmond et al. [25]	174	Study group: 29% males 71% females, control group: 43% males 57% females	33	Pincer type, mixed type
Krych et al. [23]	36	100% females	38.5	Pincer type, mixed type
Syed et al. [21]	140	Not mentioned	Not mentioned	Pincer type, mixed type

mHHS modified Harris Hip Score, *WOMAC* Western Ontario and McMaster Universities Osteoarthritis Index, *VAS* visual analogue scale, *HOS* Hip Outcome Score, *HOS-ADL* Hip Outcome Score-Activities of Daily Living, *HOS-SSS* Hip Outcome Score-Sports-Specific Subscale

Table 3 Scales measuring the clinical outcome per study and achieved statistical improvement (or not)

Author(s)	Clinical outcome scales	Statistical improvement from preop- to postoperative scores
Comba et al. [26]	mHHS, WOMAC, VAS pain, VAS satisfaction	Yes
Ilizalitturi et al. [24]	WOMAC	Yes
Redmond et al. [25]	mHHS, VAS, NAHS, HOS-ADL, HOS-SSS	Yes (but not between groups)
Krych et al. [23]	HOS, VAS	Yes (in favor of the group with labral detachment)
Syed et al. [21]	N/A	84% of patients improved (but no statistical analysis)

two prospective comparative trials [23, 25], patients were significantly improved in both the study and the control groups (Table 3).

In a prospective level III clinical study, Redmond et al. [25] compared the outcomes of patients who underwent arthroscopic acetabuloplasty without labral detachment (study group), with a group of patients who underwent acetabuloplasty with labral detachment (control group). The results of this study illustrated that there was not any significant difference among groups concerning revision rates and patient-reported outcome scores [25]. On the contrary, in a randomized controlled trial (level I) Krych et al. [23] illustrated that a greater percentage of patients in the labral repair group (study group: detachment and reattachment of the labrum) felt that their hip had returned to "normal" function than in the group which received an arthroscopic acetabuloplasty with chondrolabral preservation (control group: labral debridement). Even though both groups utterly improved the patient-reported outcome score, the labral refixation group depicted a significantly better Hip Outcome Score for Activities of Daily Living (HOS-ADL) and VAS than the chondrolabral preservation group [23].

The reoperations' rate, which was reported in only 60% of the studies, was very low (6.7% of the hips which were treated with acetabuloplasty without any labral detachment) (Table 4).

Discussion

All studies included in this review tended to show clinical improvement in the mid-term follow-up of the treated patients with the use of the aforementioned interventional technique. Arthroscopic acetabuloplasty with chondrolabral preservation seemed to be a safe and effective procedure, with low revision rate in patients suffering from femoroacetabular impingement without isolated CAM.

The definition of FAI and its natural history is still under debate. Several studies have demonstrated evidence supporting the theory that especially CAM-type FAI is a strong risk factor for the development of secondary osteoarthritis (OA) of the hip, whereas the correlation between pincer-type FAI and OA remains controversial [27–29].

The labrum appears to have several important functions in the hip joint; these include joint stability, load bearing, synovial fluid regulation and maintenance of the suction seal [30, 31]. Traditionally, a detachment of the labrum is performed during the arthroscopy in order to expose the pathological acetabular rim [32]. Gedouin et al. [33] presented good results with labrum detachment and reattachment, measured with the WOMAC score.

However, the chondrolabral junction has an established limited ability to heal after detachment. Philippon et al. [34] used an ovine experimental model to show that labral healing was incomplete, with a shallow, superficial cleft remaining at the junction of the labrum and the articular surface of the acetabulum. A potential cause for limited healing at the chondrolabral junction could be the result of vascular compromise [20]. Kelly et al. [35] depicted in a cadaveric study that hip labrum is relatively avascular. Particularly, it was the articular side of the labrum, which was found relatively avascular compared with the capsular side [35]. Taking into consideration that the traditional labral repair and osteoplasty techniques likely transect labral blood vessels [36], the chondrolabral junction is at particular risk.

More recently, technical refinements have allowed for acetabuloplasty without detaching the labrum when chondrolabral junction is intact [25] (Fig. 2).

This technique preserves the transitional zone between chondral surface and labrum. When acetabuloplasty can adequately be performed without detaching the labrum, this may be preferable for the preservation of the transitional zone between chondral surface and labrum [25]. To our knowledge, our review was the first to analyze the clinical

Table 4 Reoperations' rate and take home message per article

Author(s)	Reoperation	Take home message
Comba et al. [26]	Three out of 44 patients	Arthroscopic acetabuloplasty without labral detachment obtained good clinical outcomes in terms of functional scores, pain and satisfaction
Ilizalitturi et al. [24]	One out of 50 patients	The "over-the-top" technique provides good to excellent results for the treatment of the pincer and mixed deformities in FAI
Redmond et al. [25]	Eight patients of study group, 8 patients of control group	Arthroscopic acetabuloplasty and labral refixation without detachment in cases with an intact chondrolabral junction resulted in similar patient outcomes compared with acetabuloplasty with labral detachment
Krych et al. [23]	N/A	Arthroscopic treatment with labral repair (with labral detachment) in female patients resulted in superior improvement in hip functional outcomes compared with labral debridement (no detachment)
Syed et al. [21]	N/A	Performing chondrolabral preservation during acetabular osteoplasty is intended to allow for anatomical restoration of the acetabular labrum during arthroscopic intervention for FAI

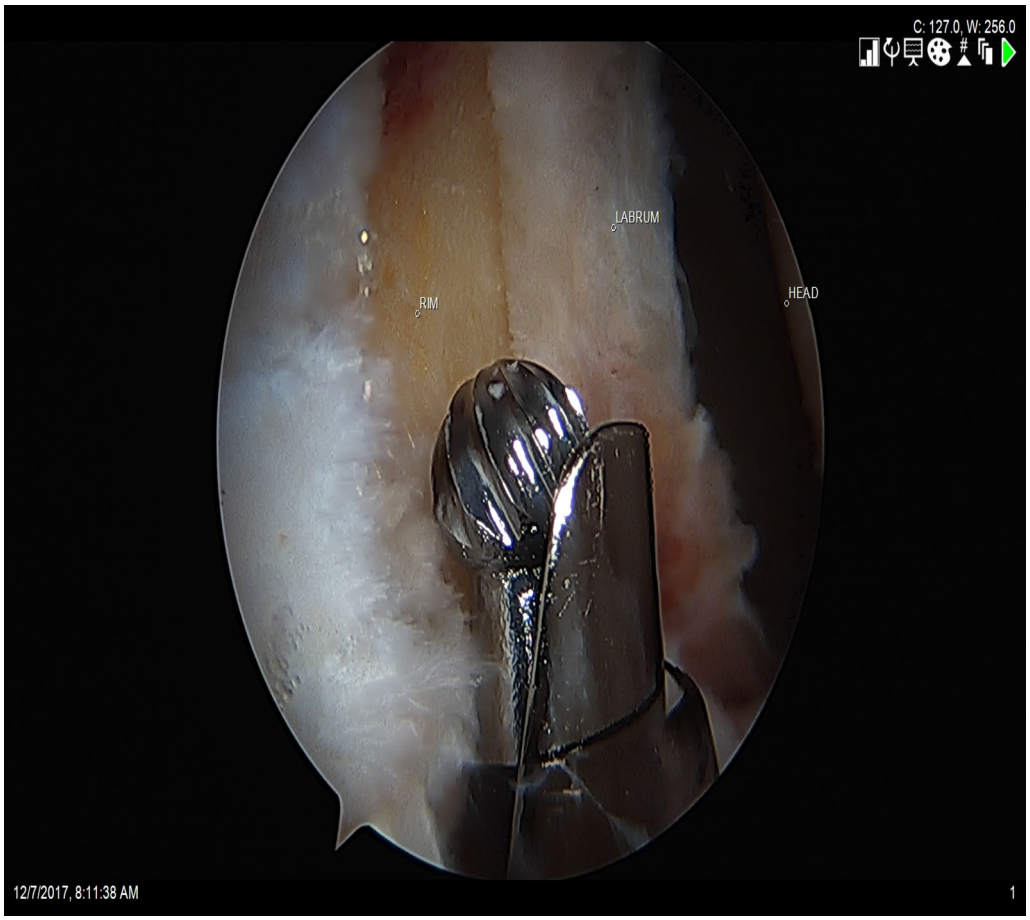

Fig. 2 Intraoperative image from the personal archive of the authors illustrating the "over-the-top" reaming technique of the acetabulum without detaching the labrum

outcome of arthroscopic acetabuloplasty with chondrolabral preservation in patients suffering from pincer-type or mixed-type FAI (without isolated CAM).

Despite studying relatively large series of patients treated with rim resection without taking down the labrum, both the studies of Comba et al. and Ilizaliturri et al. [24, 26] did not involve any control group of patients to validate their results. In addition, the mean follow-up of both their clinical series was not long term; thus, their assessment of articular survival over time could be of low estimate [24, 26]. The comparative study of Krych et al. [23] was not blinded, while the number of patients per group was rather small. Limitations of the study conducted by Redmond et al. [25] included the retrospective design, short-term follow-up and some differences in anatomy between groups. The follow-up period of two years was inadequate for long-term assessment, although this time frame was consistent with previous reports on labral repair [25].

Finally, although Syed et al. [21] described a new technique of arthroscopic acetabuloplasty with subperiosteal elevation of the labrum/chondral complex without detaching the labrum, their article contained no statistical analysis, demographic or clinical characteristics of the patients. The quality of the clinical part of this study was poor, and no definitive conclusions could be drawn [21]. After all, it was not the purpose of those authors [21] to conduct a clinical trial but to illustrate a new technique, recently named as "in-round" labral repair (different from the already described over-the-top technique) [37], with its pearls and pitfalls. The main advantage of the "in-round" technique was that it allowed for contouring of the underlying pincer deformity without compromising the contiguous transition zone between the articular surface of the acetabulum and the labrum. A limitation of their chondrolabral preservation technique was that it was more technically demanding than the over-the-top technique and, therefore, it may require more traction time [21]. A properly designed and conducted clinical study is definitely needed to assess this alternative new technique.

This systematic review was not without limitations. The number of the studies was small for safe conclusions, while the heterogeneity of the clinical scores used as well as the

different study designs (from level I to level V) prevented us from performing a meta-analysis. Finally, only two studies used a second group for comparison of the results. As a result, the majority of the studies were subjected to selection, performance and detection bias.

Conclusions

The different techniques of arthroscopic acetabuloplasty combined with chondrolabral preservation illustrated encouraging results in patients suffering from pincer-type or mixed-type FAI. However, the available clinical evidence was limited and insufficient to establish any superiority of these techniques over the traditional labral detachment and sequential reattachment. In relation to the optimal treatment of FAI without isolated CAM, further research of higher quality is recommended to be conducted in order to lead to definitive conclusions.

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Compliance with Ethical Standards

Conflict of interest Author A declares that he has no conflict of interest. Author B has received grants from Stryker Inc. (research support), DJO Surgical (personal fees), Intellijoint Inc. (personal fees) and Imagen Inc. (personal fees), outside the submitted work.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was not required for this type of study (systematic review of the literature).

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