



Review

Radiological variables associated with progression of femoroacetabular impingement of the hip: A systematic review



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ABSTRACT

Objectives: Femoroacetabular impingement is gaining increased recognition as a cause of hip dysfunction. Of great concern is its potential association with labral tears and osteoarthritis. This systematic review examines the evidence regarding radiographic variables associated with the progression of femoroacetabular impingement.

Design: Systematic review.

Methods: Articles were selected following a comprehensive search of PubMed, CINAHL, SportDiscus, Embase, and Medline databases from database inception through October 2012. Inclusion criteria involved (1) estimates of the association between prognostic variables and progression of femoroacetabular impingement, (2) prospective or retrospective design, (3) patients diagnosed with femoroacetabular impingement based on established criteria, (4) the outcome of interest was radiologic and/or clinical progression of femoroacetabular impingement, and (5) access to the full text. Two independent reviewers assessed the methodological quality of each study and the association between prognostic variables and femoroacetabular impingement progression.

Results: Thirteen articles met the inclusion criteria; nine were considered to be of high quality. Moderate evidence of progression of femoroacetabular impingement to labral pathology was associated with increased alpha angle. Moderate evidence for their lack of association with progression of FAI was associated with alpha angle with respect to development of osteoarthritis, acetabular index, center edge angle, coxa profunda, coxa vara, and pistol grip deformity.

Conclusions: There is moderate evidence that increased alpha angle at baseline is associated with progression of femoroacetabular impingement to labral tear. Moderate evidence suggests a lack of association between other radiographic variables and progression of femoroacetabular impingement.

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1. Introduction

Femoroacetabular impingement (FAI) has been identified as a common source of hip pain and dysfunction, and the leading cause of acetabular labral tears in active, young adults.¹ Previous literature has reported an estimated 10–15% prevalence rate of FAI in the general population,^{2,3} although estimates range anywhere from

10% to 39% depending upon the criteria used to diagnose FAI.^{4,5} In recent years, convincing evidence has emerged to support the theory that FAI may be a precursor of early hip osteoarthritis (OA) in up to 40% of patients with a prior diagnosis of idiopathic OA of the hip.^{1,6–8} In patients <55 years who have already undergone total hip arthroplasty (THA) for primary hip OA, definite FAI was reported in 36% of preoperative radiographs.⁹

Given the concerns for progression from a biomechanical deformity to further injury, damage, or disease, studies suggest that surgery is the most logical treatment when it comes to the presence of FAI.^{8,10–13} Based on a 2010 review,¹⁴ direct mean costs of hip arthroscopy averaged \$11,850 US dollars, a costly expense given

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not all patients report satisfactory results with up to 30% requiring eventual total hip arthroplasty.^{8,15}

While FAI may be a precursor to developing OA, recent studies have identified radiographic findings of FAI in asymptomatic populations.¹ This finding is notable as it suggests that not all of those with FAI will progress to OA or require surgery. FAI is a diagnosis that manifests inconsistently in those afflicted and therefore it would be useful to identify variables that are associated with progression to degenerative changes in this group of patients (e.g. cartilage delamination, labral tears, hip OA).

Prognostic studies provide patients, physicians, and third party payers with expectations with respect to the course of symptoms and they also help to distinguish between patients who are at high risk for worsening pain and disability versus those with a more favorable clinical course. The objective of this paper was to systematically review the evidence regarding useful prognostic variables associated with the progression of FAI. This review involved a systematic review of available articles using contemporary methods of identification and assessment of the available evidence.^{16,17} The findings are intended to assist practitioners develop more efficient intervention strategies for patients with FAI.

2. Methods

This systematic review was conducted and reported according to the protocol outlined by PRISMA using a research question framed by PICOS methodology. PICOS is a mnemonic representing population (e.g. adults), intervention (e.g. variables associated with progression of FAI), comparison (e.g. those without progression), outcome (e.g. surgery), and study design (prospective).

In order to make the search of articles on prognosis as comprehensive as possible, a systematic, computerized search of the literature based on recommendations by Wilczynski et al.^{16,17} in PubMed, CINAHL, SportDiscus, Embase, and Medline databases was concluded in October 2012. This generic search strategy to find studies on prognosis was then combined with a subject-specific strategy addressing femoroacetabular impingement of the hip (Appendix A). To identify relevant articles, titles and abstracts of all identified citations were independently screened by two reviewers (AAW, AEK) applying the *a priori* inclusion/exclusion criteria and agreement was measured using the kappa statistic (Fig. 1). Agreement between the two authors regarding which articles to read in full was determined by consensus. Full text articles were retrieved if the abstract provided insufficient information to establish eligibility or if the article had passed the first eligibility screening. With the remaining articles, the same two authors (AAW, AEK) read the entire paper and again, a kappa value was calculated to measure agreement as to which articles to retain for final analysis (Fig. 1). The reference lists of all selected publications were screened by both reviewers (AAW, AEK) to retrieve relevant publications that were not identified in the computerized search. A hand search was also conducted which included one author's (AAW) private collections.

An article was eligible for inclusion if it met all of the following criteria: (1) the statistical association (Risk Ratio, Odds Ratio, *p*-value) of at least one prognostic variable with the outcome of interest was reported; (2) data were derived from a prospective or retrospective cohort of subjects; (3) baseline radiographic or clinical evidence of FAI was based on established criteria including increased alpha angle, neck shaft angle, presence of a crossover sign, center edge angle, and/or a positive anterior impingement test on clinical examination^{18–21}; (4) the outcome of interest was radiologic and/or clinical progression of FAI (e.g. degenerative changes in terms of development of early hip osteoarthritis, labral tear, surgery); and (5) the article was available in full text. No language restrictions were imposed. To eliminate potential

confounders and draw conclusions purely on the presence of FAI an article was excluded if: (1) the study population focused on patients with metabolic diseases associated with joint or bone disease or (2) the article discussed prognosis following joint replacement surgery, osteotomy, total hip arthroplasty, or other specific surgery.

The methodological quality of each of the studies was assessed independently by two reviewers (AAW, EJH). Reviewers were not masked to trial identifiers such as authors' and journals' names. To our knowledge, there is presently no consensus standard for the assessment of prognostic studies. Therefore, we used a modified version of standardized checklists used in previous systematic reviews of prognostic variables for patients with musculoskeletal disorders^{22–24} that reflected the important methodological aspects of the study as described by Altman et al.²⁵ The final checklist consisted of 18 items (available from corresponding author), with each having a 'yes'/'no'/'don't know' answer option. A 'yes' score indicates sufficient information and a positive assessment, with bias considered unlikely. A 'no' score indicates sufficient information, but potential bias from inadequate design or conduct. A 'don't know' score indicates insufficient information was provided in the article or methodology was unclear. Disagreements among the reviewers were discussed during a consensus meeting. A detailed explanation of each of the criteria is available from the first author.

The maximum attainable score on the criteria list was eighteen. The total score was the count of all the criteria that scored 'yes'. 'No' and 'don't know' scores carried a zero score value. For each study a total quality score was given based on the information from all the available publications. *A priori*, a study was considered 'high quality' if it scored ≥ 12 points ($\geq 66.6\%$ of the maximum attainable score) and 'low quality' if scores were < 12 points. The cut-point score is arbitrary but similar to other previously mentioned systematic reviews on prognosis.^{23,24}

One reviewer (AAW) independently extracted information and data regarding study population, setting, outcome measures, prognostic variables, and strength of association statistics associated with the prognostic variables. Another reviewer (EJH) reviewed and confirmed the abstracted results. The second reviewer (EJH) was not blinded to the results abstracted by the first reviewer (AAW).

Inter-observer agreement of quality assessment was assessed using kappa statistics. We tabulated the available evidence for each prognostic variable by reporting the strength and grade of the available evidence and the methodological quality of the articles. The strength of evidence for prognostic variables associated with progression of FAI of the hip was assessed by defining four grades of evidence based on criteria established by the Center for Evidence-Based Medicine²⁶ (Table 1). Findings were reported as relative risks (RRs), odds ratios (ORs), hazard ratios (HRs) or *p*-values.

3. Results

Initially, the search yielded 2325 citations (PubMed 674; Cinahl & SportDiscus 444; and Embase & Medline 1207). Of these, 1016 duplicates were deleted leaving 1309 titles with abstracts for review. After the first screening, the full-text studies of 49 potentially eligible citations were retrieved. Following a consensus meeting a total of 13 studies were included in the review^{27–39} (Fig. 1). Reference checking and hand searching did not provide any additional studies.

Supplementary Table 2 (online only) outlines the characteristics of the articles including study population, outcome measures, follow-up, prognostic variables, and the strength of association with outcome (estimates and 95% confidence interval). Of the 13 different articles, 9 included patients undergoing or scheduled for

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