Sources and quality of literature addressing femoroacetabular impingement: a scoping review 2011–2015

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Abstract A systematic review was performed to explore the current trends over the last 5 years in femoroacetabular impingement (FAI) literature and compare the quality and sources of publications in the literature to that published previously. We identified 1066 relevant studies including 186,572 patients. The number of publications increased during the reviewed time period with the most dramatic increase from 2011 to 2013. Seventy-three percent ($N=786$) of all studies were of levels 4 and 5 quality evidence. The percent of publications which were levels 1, 2 and 3 increased by almost twofold from 16.1 % ($N=26$) to 28.7 % ($N=51$) between 2011 and 2015. In comparison to previous work, there has been 3.5-fold increase in the number of publications over the past 5 years with a shift

towards improving the level of evidence available guiding the arthroscopic management of FAI.

Level of evidence: IV—Systematic Review

Keywords Femoroacetabular impingement · FAI · Surgery · Systematic review · Evidence · Hip arthroscopy

Introduction

Femoroacetabular Impingement (FAI) results from an incongruence between the femoral head-neck and acetabulum and is recognized as a common cause of hip pain in the young adult and a potential cause of osteoarthritis of the hip [1–3].

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Traditionally, this condition was treated through open hip dislocation; however, advances in arthroscopic techniques have allowed for the management of this condition in a minimally invasive manner [4•].

Hip arthroscopy is now one of the fastest growing fields in orthopaedic surgery. The number of hip arthroscopy procedures increased 18-fold in the decade between 1999 and 2009 [5]. The *InterNational Femoroacetabular Impingement Optimal Care Update Survey* (IN FOCUS) found that 74 % of graduating orthopaedic surgeons gained hip arthroscopy training during residency with data suggesting that a tipping point towards further uptake has been reached [4•]. This has resulted in a documented 17-fold increase in hip arthroscopy procedures among newly trained surgeons between 2006 and 2010 [5–7].

With this rapid increase in clinical volume, there has been a corresponding exponential growth in the literature related to hip arthroscopy [8]. The most recent systematic review evaluating the sources and quality of FAI literature identified a fivefold increase in publications from 2005 to 2010 [9•]. This systematic review documents that more than half of the available literature consisted of level IV and level V studies and no randomized control trials were identified [9•].

The aim of this systematic review was to revisit the status of the sources and quality of FAI literature and expand upon previous work. We intended to systematically review the literature within 2011–2015 to identify literature trends since the previous study which evaluated the literature between the years 2005 and 2010. It is hypothesized that as the clinical uptake of hip arthroscopy continues to increase, the sources and quality of the FAI literature have improved as well.

Methods

This study was conducted according to the methods of the Cochrane Handbook and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [10, 11].

Study eligibility

Studies meeting the following inclusion criterion were included in this review: publication in a peer-reviewed journal over the last 5 years, focused on FAI in any age or gender, all levels of evidence and published in the English language. We excluded editorial comments, letters to the editor and instructional course lectures.

Identification of studies

Two reviewers (K.O., P.R.) independently searched MEDLINE and Embase databases for studies published over

the last 5 years from January 1, 2011 to December 31, 2015. The search was conducted on January 2, 2016 and replicated the search of a previous publication in with the aim of comparing and contrasting trends in FAI literature [9•]. The search strategy combined the following search terms: FAI, hip and impingement [9•]. The articles were initially screened for eligibility using titles and abstracts. Following initial screening, a full text review was conducted on all studies deemed relevant. Any disagreements were resolved by consensus discussion between the reviewers. If a consensus could not be reached, a final decision on inclusion was made with the first author (M.K.).

Data extraction

Data were extracted by five reviewers (P.R., K.O., N.H., S.E., M.P.) using a piloted electronic data extraction form (Microsoft Excel, version 15.2, Microsoft Corporation, Redmond, WA, USA), and all extracted data was verified by the first author (M.K) to ensure accuracy prior to statistical analysis. The following data was extracted from all studies during the full text review: year of publication, location of study, study design, type of study, level of evidence, number of patients and hips, gender, weighted mean age of patients and type and title of journal.

Study design was categorized as a review, clinical, radiological or biomechanical/cadaveric. The study type was categorized as therapeutic, prognostic, diagnostic, prevalence, mixed or not applicable. See Table 1 for details regarding study type and design. Each article was grouped under a journal category according to its name and/or description. The type of journal of publication was categorized as radiology, orthopaedic, sports medicine, physiotherapy, general medicine, basic science, rheumatology or computer technology.

Data analysis

Interobserver agreement for reviewers' assessments of study eligibility was calculated with the Cohen k coefficient [12]. On the basis of the recommendations of Landis and Koch, a k of 0 to 0.2 represents slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; and 0.61 to 0.80, substantial agreement. A value greater than 0.80 is considered to indicate almost complete agreement. Descriptive statistics were used to summarize the data. All analyses were performed using Microsoft Excel (version 15.2, Microsoft Corporation, Redmond, WA, USA) and SPSS Statistics (version 21, IBM, Armonk, NY, USA).

Table 1 Definitions of categories used in the data abstraction

Category	Description
Study design	
Review	Included expert opinions, systematic and narrative reviews
Clinical	Included any articles that involved study participants in the methodological design to generate clinically relevant outcomes
Radiological	Included articles with a primary focus on characterizing or analyzing diagnostic imaging
Biomechanical/cadaveric	Included basic science articles or studies utilizing cadavers to generate biomechanical data
Study type	
Therapeutic	A study exploring the results of treatment
Prognostic	A study investigating the effect of a patient characteristic on the outcome of disease
Diagnostic	A study evaluating a diagnostic test
Mixed (more than 1 applicable category)	An article that had more than one study design applicable
Not applicable	A study that was biomechanical, cadaveric or basic science in design

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Results

Identification of studies

The electronic search identified 3152 potentially relevant studies. Following exclusion of duplicate articles and application of exclusion criteria, 1358 were eligible for full text review. Of the 2086 excluded articles, 995 were unrelated to the topic and 339 were either editorial comments, letters to the editor or instructional course lectures. Following full text review, 1066 articles were eligible for inclusion in this systematic review. The kappa for overall agreement between reviewers for final eligibility decision was 0.50 (95 % CI 0.47–0.53) indicating moderate agreement (Fig. 1).

Characteristics of included studies

From the included studies, the total number of patients included in this systematic review was 186,572. The median number of patients in each study was 50 (IQR 22–122) with approximately equal distribution among males (78,145) and females (71,709) when reported. The weighted mean age of participants was 33 years with a weighted mean age range of 19 to 52.

Literature and source trends

Between 2011 and 2015, there was an increasing number of FAI-related publications. The most dramatic increase was noted from 2011 to 2013 where there was an approximately 174 % ($N=161$ vs. 281) increase in publications annually (Fig. 2). The number of FAI-related publications decreased by 30 % from 257 to 179 in 2014 to 2015. The percent of

publications of evidence levels 1–3 increased by 175 % from 16.1 to 28.7 % between 2011 and 2015. Seventy-three percent ($N=786$) of all studies were of levels 4 and 5 quality evidence. Specifically, there were 522 level 4 studies (48.9 %) and 264 level 5 studies (24.7 %). We identified 169 level 3 studies (15.8 %), 105 level 2 studies (9.8 %) and six level 1 studies (0.6 %) of which there were five randomized control trials identified (Fig. 3).

Fig. 1 Flow of articles through screening and reasons for exclusion

Fig. 2 Number of publications per year 2011–2015

We found that the majority of articles published were clinical (538, 50.4 %), followed by review articles (232, 21.7 %), radiographic studies (208, 19.5 %) and cadaveric studies (88, 8.2 %) (Fig. 4). The number of review articles increased from 34 (21.1 %) in 2011 to 52 (29.2 %) in 2015 with a peak of 67 (23.8 %) in 2013. Of the 232 review articles identified, 62 were systematic reviews (26.7 %) and 160 were narrative reviews (68.9 %). The number of systematic reviews also increased across the time period reviewed with more than a threefold increase between 2011 and 2015 (8 to 25). Clinical articles increased 1.8-fold from 77 articles in 2011 to 139 in 2014. Of the 538 clinical articles identified, 393 articles were found to be case series or case reports (73.0 %) and 78 to be cohort-type studies (14.5 %).

Therapeutic and diagnostic studies constituted the majority of included study types (366, 34 % and 302, 28.3 %, respectively) followed by prognostic (134, 12.6 %), mixed

Fig. 3 Level of evidence by year 2011–2015

Fig. 4 Distribution of FAI study designs

(128, 12.0 %) and prevalence (60, 5.6 %) studies (Fig. 5). The majority of publications were in orthopaedic and sports medicine journals (668, 62.6 % and 166, 15.6 %, respectively) followed by radiologic journals (99, 9.2 %) and others (133, 12.4 %) (Fig. 6).

The majority of publications were performed in the USA (601, 56.4 %) followed by the UK (150, 14.1 %), Germany (96, 9.0 %) and Italy (40, 3.7 %). The single most FAI-related publications came from the *Journal of Arthroscopic and Related Surgery* which published 183 FAI articles (17 %) followed by the *American Journal of Sports Medicine* (79, 7.4 %).

Discussion

Key findings

This systematic review of FAI literature identified continued growth in the number of FAI-related publications over time. We found 3.5 times as many articles relevant to FAI for inclusion from 2011 to 2015 than Ayeni et al. identified between 2005 and 2010 using the same search criteria [9•]. Additionally, this review also identified an overall increase in the number of publications over the 5-year review with a peak in 2013. Consistent with the previous literature search,

Fig. 5 Distribution of FAI study types

Fig. 6 Number of articles per journal type 2011–2015

we found that the majority of FAI-related articles were published in orthopaedic and sports medicine journals; however, an increasing number of articles are now also being published in radiological and general medical journals.

Overall, 73 % of publications identified were of level 4 or 5 evidence which is consistent with other recent reviews of the FAI literature [13, 14]. Additionally, the majority of FAI publications were of small sample size with a median of 50 included patients (IQR 22–122) identified in this systematic review. Studies with small sample sizes and observational study designs are at significant risk of potential bias regarding findings which means that the findings of the current studies may be imprecise or not powered to detect findings [15, 16]. Although case series are useful in terms of hypothesis generation, it is not always possible to rely on conclusions and findings from such papers due to their inherent limitations [17].

An encouraging trend was identified in that the number of publications of level 3 evidence or better increased significantly over the years reviewed by almost twofold from 16.1 to 28.7 %. Additionally, 100 level 2 studies and a number of randomized control trials were found in this systemic review. With regard to review articles published during the reviewed time period, the number of systematic reviews increased threefold between 2011 and 2015. This is encouraging as it confirms that literature addressing FAI surgery is progressing along a well-described innovation curve towards not only increased uptake and utilization but also improvements in the level of evidence available to guide management [18]. Findings from the previously published *IN FOCUS* study suggested that the uptake of FAI surgery has reached a tipping point which would correspond with an increase in the quality of evidence available, which was confirmed in this review [4•].

With this improvement in the quality of evidence, we also noted an important focus on patient important outcomes. Not only did the number of clinical articles published over the 5-year period increase almost twofold but also the majority of these articles were found to be therapeutic or diagnostic in nature. The focus on clinical and patient important outcomes is critical to provide continued refinement of surgical technique and future associated improvements in patient outcomes.

The most prolific country with regard to FAI-related publications was the USA followed by the UK and Germany. Previous reviews have also found a similar trend with the majority of research being performed in North America followed by European countries [14]. Our review however also identified a limited number of publications now being produced from South America in contrast to prior work [14]. The reasons for this bias towards North American and European countries have been suggested to include availability of research funding and infrastructure as well as an English-language bias towards published work and study inclusion restrictions towards English-only studies [14].

Strengths and limitations

This systematic review provided a comprehensive evaluation of the literature utilizing broad search terms and duplicate screening by reviewers. We utilized a piloted data extraction form to ensure comprehensiveness and assessed agreement regarding study selection between reviewers to be moderate. The methods by which we conducted this review allow us to accurately compare the trends in the literature to that previously published by Ayeni et al. [9•]. Additionally, all data was reviewed by

the primary author for accuracy prior to statistical analysis.

This systematic review does have some limitations. Although an overall increase in the number of publications from 2011 to 2015 with a peak in 2013 was found, we did note that the number of FAI-related publications decreased by 30 % between 2014 and 2015. This peak has been previously described in the literature and the decrease may potentially be explained by a trend towards specialized publication in more content-specific journals which are not yet PubMed indexed or indexed with specific terms not captured by our broad search criteria [19]. Only publications in the English language were included for feasibility; thus, the potential for language and publication bias does exist and may be a reason for our findings of limited publications in certain non-English-speaking countries. Also, in order to replicate the methodology of previous work, some categorizations remained ambiguous and may have some overlap in the classification of certain studies.

Conclusion

There has been a continued increase in the number of publications over the past 5 years with a shift towards improved level of evidence. Future research to build on this improvement through a continued shift towards larger prospective randomized trials and cohort studies will improve our understanding of the diagnosis and management of FAI.

Compliance with ethical standards

Conflict of interest All of the authors declare that they have no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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