REVIEW

Influence of hip dysplasia on the development of osteoarthritis of the hip

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Appendix W1 is available at <http://www.annrheumdis.com/supplemental>

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Background: It has been suggested that in some patients with primary hip osteoarthritis (OA), the disease occurs as a consequence of acetabular dysplasia or hip dysplasia (HD).

Objective: To carry out a systematic review to investigate the association between acetabular dysplasia and hip OA.

Methods: A database search of Medline, Embase, and the Cochrane library was carried out, and articles that aimed at studying the relationship between HD and hip OA were identified. The methodological quality of the selected studies was assessed using a standardised set of criteria, and a best evidence synthesis was used to summarise the results from the individual studies.

Results: Five cohort studies and four case-control studies were included in this review. One cohort study had the correct design to answer the question and was considered to be a high quality study. This study reported a positive association between HD and hip OA. Overall, limited evidence was found for a positive association between HD and hip OA. Most studies included older people. In younger age groups the relation between HD and OA or hip complaints may be much higher.

Conclusion: The evidence for the influence of HD on the occurrence of hip OA, at age 50–60 or older, is limited.

Osteoarthritis of the hip (hip OA) is an increasing problem in Western societies, and is a major cause of morbidity and disability, especially among the elderly. In addition to the pain and discomfort it causes, OA has major economic consequences.¹

The reported prevalence of hip OA varies widely owing to differences in the definition of OA or the selection of the study group. Studies in Europe have estimated that about 7–25% of white people over the age of 55 have hip OA. The prevalence of hip OA appears to be lowest in Asians, followed by African black and native American populations, and is highest in white Europeans.^{2–5}

It has been suggested that in some patients with primary hip OA, the disease occurs as a consequence of acetabular dysplasia or hip dysplasia (HD), which persists into adult life. Some radiological observations in patients with hip OA, and follow up studies of subjects with HD support this theory.^{6–8} However, not all studies have reported a positive association.⁹

To investigate if HD pre-dates hip OA, we performed a systematic review, using modern methods for systematically identifying and assessing the available studies.

METHODS

Identification and selection of the literature

Relevant publications were searched using the Cochrane library (1993–April 2000), Medline (1966–April 2000), and Embase (1980–April 2000) databases. The following key-words were used: (hip and (arthritis or arthrosis or osteoarthritis or osteoarthrosis) or coxarthrosis) and (risk factor or causative or determinants or predictor or aetiology) and (case-control or retrospective or prospective or longitudinal or follow up or cohort). (A detailed list can be obtained from the corresponding author.) We extended the

search by screening the reference lists of all relevant articles identified.

A study was eligible for inclusion if it fulfilled all of the following criteria: (a) one of the aims of the study was to investigate an association between HD and hip OA; (b) the articles were written in English, Dutch, German, French, Danish, Norwegian, or Swedish; (c) the article was a full text article; (d) the patients in the studies had radiological and/or clinical hip OA, a (total) hip replacement, or were on the waiting list for one; and (e) the study design was a cohort or a case-control study.

A study was excluded if the studied population had a specific underlying pathology, such as trauma (fractures), infection, rheumatoid arthritis, ankylosing spondylitis, Perthes' disease, tuberculosis, haemochromatosis, sickle cell disease, Cushing's disease, or femoral head necrosis.

Methodological quality assessment

The variation of the methodological quality of observational studies may influence the results and conclusions of a systematic review. Therefore, the quality of each study included was assessed by the following procedure.

Two reviewers independently scored the quality of the selected papers according to a standardised set of criteria (table 1). These criteria have been used in previous reviews of observational studies in the field of musculoskeletal disorders and were modified to cover the topic of our review.^{10–13} The criteria concern both the internal validity and the informativeness of the study. Only items reflecting the internal validity of the studies were used to assess the methodological

Abbreviations: AD, acetabular depth; CE, centre-edge; HD, hip dysplasia; IVU, intravenous urography; OA, osteoarthritis

Table 1 List of criteria for the assessment of the methodological quality of cohort and case-control designed studies

Item	Criteria	V/I*	CH/CC†
<i>Study group</i>			
1	Selection before disease was present or at uniform point	V	CH/CC
2	Cases and controls were drawn from the same population	V	CC
3	Participation rate $\geq 80\%$ for cases/cohort	V	CH/CC
4	Participation rate $\geq 80\%$ for controls	V	CC
5	Sufficient description of baseline characteristics	I	CH/CC
<i>Assessment of risk factor</i>			
6	Exposure assessment was "blinded"	V	CH/CC
7	Exposure was measured identically in study group	V	CC
8	Exposure was assessed before the outcome	V	CH/CC
<i>Assessment of hip OA</i>			
9	Hip OA was assessed identically in study group	V	CH/CC
10	Presence of hip OA was assessed reproducibly	V	CH/CC
11	Presence of hip OA was according to valid definitions	V	CH/CC
12	Classification was standardised	I	CH/CC
<i>Study design</i>			
13	Prospective design was used	V	CH/CC
14	Follow up time ≥ 3 years	V	CH
15	Withdrawals $\leq 20\%$	V	CH
16	Information about completers v withdrawals	I	CH
<i>Analysis and data presentation</i>			
17	Frequencies of most important outcomes were given	I	CH/CC
18	Appropriate analysis techniques were used	V	CH/CC
19	Adjusted for at least age and sex	V	CH/CC

*V, criterion on validity/precision; I, criterion on informativeness; †CH, applicable to cohort designed studies; CC, applicable to case-control designed studies.

quality (table 1 and appendix W1, available at <http://www.annrheumdis.com/supplemental>).

In cases of disagreement, both reviewers tried to achieve consensus; if disagreements were not resolved, a third reviewer was consulted to achieve a final judgment.

Several items are not applicable to a certain type of study design (for example, cohort study or case-control study), and therefore do not contribute to the total score of that particular study. This means that the maximum score of each study (= 100%) was based only on the items applicable to that particular type of study design. Positive scores were summed to give an overall internal validity score.

Best evidence synthesis

Because the study population, methodological quality and determinants, and outcome measures for hip OA are heterogeneous in observational studies, we refrained from statistically pooling the data,¹⁴ and performed a "best evidence synthesis".^{10 11 14–17}

The studies were stratified according to the type of study design. To clarify the question whether HD pre-dates hip OA, the only studies which can really answer this question are prospective cohort studies: that is they follow up patients without hip OA with the presence or absence of HD measured, forward in time, and identify who develops hip OA subsequently. Therefore these studies were judged to have the most valid design. Studies with cross sectional data on hip OA and HD were not considered in the best evidence synthesis.

Furthermore, the studies were ranked according to their methodological quality score^{10 11 18}.

- Strong evidence is provided by generally consistent findings in multiple high quality cohort studies
- Moderate evidence is provided by generally consistent findings

- In one high quality cohort study and two or more high quality case-control studies
- In three or more high quality case-control studies

- Limited evidence is provided by (generally consistent) findings

- In a single cohort study
- In ≤ 2 case-control studies

- Conflicting evidence is provided by conflicting findings (that is, $<75\%$ of the studies reported consistent findings)
- No evidence is provided when no studies can be found.

A study was considered to be of high quality if the methodological quality score was $>60\%$.

Data extraction

Two researchers (AML and SMABZ) independently collected the characteristics of the included studies. They collected items concerning the definition of the studied population, how the presence or absence of hip OA was assessed, the assessment of HD, if the study corrected for potentially confounding factors, and which results were reported.

RESULTS

Identification and selection of the literature

A total of 2921 references were identified. After an initial examination of the title and the abstract of the references, the full text of papers were screened to determine whether they met our selection criteria. Of these, 12 articles met the criteria.^{6 9 19–28} After screening the reference lists of the selected studies, one other study was included.⁸ For three studies, more than one publication reported different aspects of the studies.^{6 9 19–22 28} All publications were used to extract data about the methods used and the results. Finally, nine studies were included in this review.

Table 2 Details of the studies included in this review

Author	Definition cases/controls	Definition hip OA	Definition dysplasia	Results	Quality score (%)
Cohort					
Lane ^{6, 22}	White women in four regions of the USA with (K&L 2–4) and without (K&L 0) hip OA (n = 58/118, ≥65 years). Nested case-control with 8.3 (7.4–10.4) years' prospective follow up	x Ray (K&L)	CE angle <30°, AD <9 mm	Female with v without hip OA had: A smaller CE angle OR = 3.3 (1.1–10.1) A smaller AD OR = 0.6 (0.1–3.3) Dysplasia OR = 2.8 (1.0–7.9)	75
Murphy ²⁵	Patients after THR because of hip OA, with (K&L 3–4) and without (K&L 0–2) contralateral hip OA (n = 74/43, ≥65 years). Nested case-control with prospective follow up	x Ray (K&L)	CE angle, AD index (depth/width)	CE angle and acetabular index were significantly smaller in the patients with OA (p < 0.0001)	58
Hasegawa ^{20, 21}	Japanese patients with pre or early hip OA (n = 64, 13–62 years). Prospective follow up 12.8 (10–25) years	x Ray (JSN, sclerosis)	CE angle, AD ratio	Patients with a fast progression from pre to early hip OA had a significantly smaller CE angle, and a smaller AD ratio (p < 0.001)	50
Yoshimura ²⁸ Croft ¹⁹ Smith*	British patients after IV urography (n = 1498, 60–75 years) and Japanese people after pelvic x ray (n = 198, 60–79 years). Cross sectional	x Ray (MJS)	CE angle, AD	Correlation between MJS and CE angle: British male r = -0.37, British female r = -0.25, Japanese male r = -0.39, Japanese female r = -0.26 Correlation between MJS and AD: British male r = -0.15, British female r = -0.11, Japanese male r = -0.09, Japanese female r = -0.07	50
Lau ²³	Male Chinese and British* patients after IV urography (n = 999, 60–75 years). Cross sectional	x Ray (MJS ≤ 1.5)	CE angle <25°, AD <9 mm	People with an MJS ≤ 1.5 v >4 mm had a smaller AD (OR = 0.4 (0.05–2.9)) and a smaller CE angle (OR = 0.5 (0.03–8.7))	42
Case-control					
Laforgia ²⁴	Patients in Italy on waiting list for osteotomy or THR (n = 60, average age 77 years). Cross sectional	Waiting list	CE angle	CE angle is significantly smaller in superolateral OA, and significantly higher in concentric/medial OA than in controls	38
Murray ⁸	British patients with hip OA (n = 50). Cross sectional	Clinical (patients) x ray (JSN, cysts, osteophytes, subluxation)	CE angle <25°, AD <9 mm.	Patients with HD showed an earlier age of onset of hip OA (50.8 years v 57.7 years in control)	38
Terjesen ²⁶	Patients in Norway at orthopaedic clinics with hip complaints, with CE ≥ 20° (n = 50, 48–81 years). Cross sectional	Clinical (pain, functional disability). x Ray examination	CE angle <25°	No significant difference in CE angle between patients with v without hip OA	31
Wedge ²⁷	Patients in Canada with primary hip OA (n = 30, 65 years). Retrospective	Clinical (patients). x Ray examination	CE angle <25°, AD <14 mm on AP x ray examination	Patients with hip OA had a significantly smaller CE angle and AD	23

*From same population as that described by Yoshimura *et al.*²⁸

AD, acetabular depth; CE angle, centre-edge angle; IV, intravenous; JSN, joint space narrowing; K&L, Kellgren and Lawrence; MJS, mean joint space width; OA, osteoarthritis; THR, total hip replacement.

Description of the studies included

Table 2 gives the characteristics of the included studies.

Five studies had a cohort design.^{6, 20, 23, 25, 28} After screening the reference lists of the selected studies, one other study was included.⁸ For three studies, more than one publication reported different aspects of the studies^{6, 9, 19–22, 28} and four studies had a case-control design.^{8, 24, 26, 27}

Three of the five cohort studies collected the data in a prospective manner,^{6, 20, 25} and only one study followed up patients without hip OA forward in time.⁶

One study included only men,²³ and one other only women.⁶ Six studies included patients aged 60–65 or older,^{6, 23–25, 27, 28} and the other three included a population with younger patients as well.^{8, 20, 26} Data on congenital HD were lacking. Three studies reported data on Asian,²⁰ or on Asian and white populations.^{23, 28} All others reported on white people.

Only one study was community based,⁶ all others were hospital based. Of these hospital based studies, two selected the patients not on the presence or absence of hip OA, but according to whether they had had an intravenous urography (IVU).^{23, 28}

In all studies, HD was assessed by measuring the centre-edge (CE) angle—that is, the angle between (a) a vertical line drawn from the centre of the femoral head at right angles to the line joining the two femoral head centres, and (b) a line from the centre of the femoral head to the lateral edge of the acetabular roof. Seven of the nine studies also measured the acetabular depth (AD; the perpendicular distance from the deepest point of the acetabular roof to the line joining the lateral margin of the acetabular roof and the upper corner of the symphysis pubis on the same side), index, or ratio.^{6, 8, 20, 23, 25, 27, 28} The cut off point for the definition of HD according to the CE angle was ≤25° in three studies^{6, 8, 23, 27} and ≤30° in one study.⁶ One study used a CE angle ≤20° as an exclusion criterion for the studied patients.²⁶

Two of the five cohort studies defined the presence of hip OA by a radiographic scoring system, described by Kellgren and Lawrence.^{6, 25} In the three other cohort studies the assessment of hip OA was based on the measurements of the joint space width. The four case-control studies based their case series on hospital patients with hip OA, so their definition of hip OA was a combination of clinical signs or complaints and radiographic abnormalities.^{8, 24, 26, 27}

relationship between HD and the occurrence of hip OA, and the single retrospective study reported no association.

Two of the five cohort studies included people who had had an IVU. Although these populations are hospital based, the requirement for an IVU implies no marked differences in acetabular dimensions, and therefore biases due to selection for treatment of hip OA, are avoided. However, the leg position during x ray examination is not standardised for an IVU, and patients with sustained hip OA tend to lie with the leg in external rotation. This rotation of the hip may influence the measurements of the CE angle. Although these differences are estimated to be small,³⁰ they may produce less reliable results. Both studies performed with data from IVU reported a negative association, whereas five of the seven other studies reported a positive association, and none reported a negative association. Also the difference in the x ray techniques used (for example, for trauma, IVU, and before hip replacement) might make it more difficult to compare the data.

Besides restrictions of the included studies, this review may also have several restrictions.

Identification and selection of the literature

Although we put much effort into identifying all relevant articles, our literature search may have some limitations, not only because some relevant articles might have been missed because they used other keywords or had unclear abstracts but also because not all published articles are indexed in databases. Additionally, we excluded articles written in languages other than English, Dutch, German, French, Danish, Norwegian, or Swedish.

To investigate the amount of potential publication bias for our study, we planned to make a funnel plot,¹⁰ but only three of the nine studies provided enough data to allow us to make such a plot. Unfortunately, this means that we are unable to visualise the possibility of publication bias in this review.

Quality assessment and best evidence synthesis

The quality assessment was challenging because no previously tested and validated criteria lists for observational studies in the field of OA have been published. In addition, limited data were found on performing a best evidence synthesis with observational studies (in contrast with randomised controlled trials).³¹ We therefore presented our methods in a reproducible manner, in order to give the reader insight into the way in which our level of evidence was reached.

In the best evidence synthesis we defined the criteria so that only prospective cohort studies are able to address the research question. In fact, only those with a disease-free population at the beginning of the study are able to do that, but because populations with early hip OA that were studied prospectively can support the evidence, we included them as well. We are however cautious about this kind of information because of the bias that can be introduced. (Acetabular deformity can pre-date hip OA.)

Explanations for the results

Despite the above mentioned biases and limitations, the evidence for an association between HD and the development of hip OA is limited. A hypothetical mechanism to explain the association is the increased joint stress due to decreased joint surface area (smaller CE angle) or joint incongruity (smaller AD).³²⁻³³

In view of the limited evidence on the positive relationship between mild forms of HD and the occurrence of hip OA in the elderly, and the lack of information in younger patients, more well designed prospective population based studies are

needed in order to provide more precise and valid information on this relation.

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