Bone & Joint Open

Supplementary Material

10.1302/2633-1462.37.BJO-2022-0049.R1

Table i. Definition of study groups. The allocation to a specific group was performed based on the morphological analysis of the conventional anteroposterior pelvic radiograph and the cross-table lateral radiographs of the hip. See also Figure 1 in the main text.

Group	Definition	Number of hips (patients)
Total	Included patients	384 (333)
Subgroups	Five subgroups were analyzed.	
Cam-type FAI	Alpha angle > 50°[1] with neck-shaft angle of 125° to 140° and with normal acetabulum (LCEA 23° to 33°)[2], not all retroversion signs positive	165 (142)
Mixed FAI*	Alpha angle > 50°[1] and LCEA 34° to 39°, not all retroversion signs positive	137 (118)
Over-coverage	LCEA 34° to 39°[2] with alpha angle < 50°, not all retroversion signs positive	38 (33)
Severe over-coverage	LCEA > 39°[3], and/or protrusio acetabuli (defined as femoral head touching or crossing the ilioischial line)	46 (41)
Acetabular retroversion	Positive crossover sign,[4] positive ischial spine sign,[5] positive posterior wall sign,[4] and retroversion index > 30%,[6] independent from alpha angle	77 (65)
Excluded	**Excluded patients are listed below with the definitions**	
Hip dysplasia	LCE-angle < 22°[2]	90 (78)
Perthes' disease	Documented avascular necrosis of femoral head in childhood	30 (25)
No obvious pathology	No obvious acetabular and femoral pathology, normal LCEA (22° to 34°), normal alpha angle (< 50°)	23 (19)
THA	Patients treated with THA	11 (11)

*The hips in the mixed-type FAI group can overlap with the other subgroups.
FAI, femoroacetabular impingement; LCEA, lateral centre-edge angle; THA, total hip arthroplasty.

Table ii. Radiological parameters and surgical treatment of all patients and of the subgroups are shown.

Parameter	Overall study group	Over-coverage	Severe over-coverage	Acetabular retroversion	Cam-type FAI	Mixed-type FAI
Number of hips (patients)	384 (333)	38 (33)	46 (41)	77 (65)	165 (142)	137 (118)
Mean age at imaging, yrs (SD, range)	33 (12, 14 to 71)	30 (12, 15 to 71)*	39 (11, 17 to 60)	27 (9, 14 to 59)	34 (12, 16 to 65)	31 (11, 14 to 67)
Mean LCEA, ° (SD, range)	33 (7, 23 to 63)	35 (2, 34 to 39)	45 (5, 39 to 63)	35 (7, 23 to 54)	28 (3, 23 to 33)	39 (5, 34 to 63)
Mean acetabular index, % (SD, range)	1 (6, -14 to 21)	-1 (5, -13 to 9)	-6 (5, -14 to 2)	0 (5, -14 to 15)	5 (5, -9 to 21)	-1 (5, -12 to 17)
Mean extrusion index, % (SD, range)	18 (7, -3 to 36)	15 (4, 10 to 26)	7 (5, -3 to 22)	16 (7, 1 to 29)	22 (5, 10 to 36)	15 (5, -1 to 29)
Mean retroversion index, % (SD, range)	15 (18, (0 to 100)	11 (10, 0 to 29)	6 (9, 0 to 28)	43 (16, 30 to 100)	8 (9, 0 to 29)	22 (21, 0 to 100)
Mean neck-shaft angle, ° (SD, range)	131 (6, 107 to 161)	133 (8, 117 to 161)	130 (7, 118 to 153)	131 (7, 110 to 146)	130 (6, 107 to 148)	130 (7, 110 to 150)
Mean alpha angle, ° (SD, range)	61 (11, 33 to 95)	46 (7, 33 to 65)	55 (13, 38 to 85)	58 (12, 37 to 87)	65 (9, 51 to 95)	64 (9, 50 to 91)
Crossover sign pos., %	81	84	59	100	78	85
Posterior wall sign pos, %	60	50	41	100	53	68
Ischial spine sign pos., %	62	66	57	100	41	82
COS, PWS, and ISS and RI > 30%	36	0	0	100	0	38
Surgical treatment, %	50					
SHD	32	32	46	30	22	39
HAS	15	5	7	8	24	9
PAO	3	0	0	16	0	6

COS, crossover sign; HAS, hip arthroscopy; ISS, ischial spine sign; LCEA, lateral centre-edge angle; FAI, femoroacetabular impingement; PAO, periacetabular osteotomy; PWS, posterior wall sign; RI, retroversion index; SD, standard deviation; SHD, surgical hip dislocation.

References

1. **Nötzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J.** The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br*. 2002;84-B(4):556–560.

2. **Tannast M, Hanke MS, Zheng G, Steppacher SD, Siebenrock KA.** What are the radiographic reference values for acetabular under- and overcoverage? *Clin Orthop Relat Res*. 2015;473(4):1234–1246.

3. **Tönnis D, Heinecke A.** Acetabular and femoral anteversion: relationship with osteoarthritis of the hip. *J Bone Joint Surg Am*. 1999;81-A(12):1747–1770.

4. **Reynolds D, Lucas J, Klaue K.** Retroversion of the acetabulum. A cause of hip pain. *J Bone Joint Surg Br*. 1999;81-B(2):281–288.

5. **Lerch TD, Boschung A, Schmaranzer F, et al.** Lower pelvic tilt, lower pelvic incidence, and increased external rotation of the iliac wing in patients with femoroacetabular impingement due to acetabular retroversion compared to hip dysplasia. *Bone Jt Open*. 2021;2(10):813–824.

6. **Steppacher SD, Lerch TD, Gharanizadeh K, et al.** Size and shape of the lunate surface in different types of pincer impingement: theoretical implications for surgical therapy. *Osteoarthr Cartil*. 2014;22(7):951–958.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Line 8	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Line 8-13 and Line 17 ff	
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Line 49 ff	
Objectives	3	State specific objectives, including any prespecified hypotheses	Line 91ff	
Methods				
Study design	4	Present key elements of study design early in the paper	Line 100	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Line 103	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Line 110	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Line 135 ff	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Line 152	
Bias	9	Describe any efforts to address potential sources of bias	Line 156	
Study size	10	Explain how the study size was arrived at	Line 110	

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Line 200ff
		(*b*) Describe any methods used to examine subgroups and interactions	Line 206ff
		(*c*) Explain how missing data were addressed	No missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	No followup study was performed
		(*e*) Describe any sensitivity analyses	No sensitivity analysis was performed
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1 and Line 100
		(b) Give reasons for non-participation at each stage	Figure 1 and Line 100
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 2
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	No followup study was performed
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	No outcome events recorded
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 3 and 4
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Tables 3 and 4
Discussion			
Key results	18	Summarise key results with reference to study objectives	Line 240
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Line 303
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Line 280
Generalisability	21	Discuss the generalisability (external validity) of the study results	Line 305
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.