Influence of Femoral Version on the Outcomes of Hip Arthroscopic Surgery for Femoroacetabular Impingement or Labral Tears

A Systematic Review and Meta-analysis

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Background: It remains controversial whether abnormal femoral version (FV) affects the outcomes of hip arthroscopic surgery for femoroacetabular impingement (FAI) or labral tears.

Purpose: To review the outcomes of hip arthroscopic surgery for FAI or labral tears in patients with normal versus abnormal FV.

Study Design: Systematic review; Level of evidence, 4.

Methods: Embase, PubMed, and the Cochrane Library were searched in July 2020 for studies reporting the outcomes after primary hip arthroscopic surgery for FAI or labral tears in patients with femoral retroversion ($<5^\circ$), femoral anteversion ($>20^\circ$), or normal FV (5°-20°). The primary outcome was the modified Harris Hip Score (mHHS), and secondary outcomes were the visual analog scale (VAS) for pain, Hip Outcome Score–Sport-Specific Subscale (HOS-SSS), Non-Arthritic Hip Score (NAHS), failure rate, and patient satisfaction. The difference in preoperative and postoperative scores (Δ) was also calculated when applicable.

Results: Included in this review were 5 studies with 822 patients who underwent hip arthroscopic surgery for FAI or labral tears; there were 166 patients with retroversion, 512 patients with normal version, and 144 patients with anteversion. Patients with retroversion and normal version had similar postoperative mHHS scores (mean difference [MD], 2.42 [95% confidence interval (CI), –3.42 to 8.26]; $P = .42$) and ΔmHHS scores (MD, –0.70 [96% CI, –8.56 to 7.15]; $P = .86$). Likewise, the patients with anteversion and normal version had similar postoperative mHHS scores (MD, –3.09 [95% CI, –7.66 to 1.48]; $P = .18$) and ΔmHHS scores (MD, –1.92 [95% CI, –6.18 to 2.34]; $P = .38$). Regarding secondary outcomes, patients with retroversion and anteversion had similar ΔNAHS scores, ΔHOS-SSS scores, ΔVAS scores, patient satisfaction, and failure rates to those with normal version, although a significant difference was found between the patients with retroversion and normal version regarding postoperative NAHS scores (MD, 5.96 [95% CI, 1.66-10.26]; $P = .007$) and postoperative HOS-SSS scores (MD, 7.32 [95% CI, 0.19-14.44]; $P = .04$).

Conclusion: The results of this review indicated that abnormal FV did not significantly influence outcomes after hip arthroscopic surgery for FAI or labral tears.

Keywords: hip; femoroacetabular impingement; hip arthroscopic surgery; femoral version; systematic review; meta-analysis

Over the past decades, hip arthroscopic surgery has become popular for femoroacetabular impingement (FAI) and labral tears,[2,37] and it was reported to be successful in 87.7% of cases in a recent meta-analysis.[30] Meanwhile, the failure rate of hip arthroscopic surgery for FAI has been reported to be 2.9% to 13.2%.[43] In addition to female sex, advanced age, hip dysplasia, high body mass index, articular cartilage damage,[43] and increased acetabulum coverage,[10] abnormal femoral version (FV)[8,13,14] has also been reported to be a risk factor for failed hip arthroscopic surgery.

Generally, FV is defined as rotation of the femoral neck axis around the femoral shaft in the transverse plane.[4,25,33] The widely accepted normal value of FV is 5° to 20°.[22] FV $>20^\circ$ is defined as anteversion or increased FV, and FV $<5^\circ$ is defined as retroversion or decreased FV.[8,14,15,18] Femoral anteversion may lead to hip instability because of insufficient femoral head coverage, especially in hips with developmental dysplasia.[32,38,39] On the other hand,

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femoral retroversion can lead to anterior impingement, decreasing functional flexion, and limited internal rotation.[22,47]

Abnormal FV has been found to be correlated with hip impingement,[1,17,22,29,42] instability,[28] and osteoarthritis[47] and might be a negative prognostic factor for hip surgery.[8,14] However, it is still controversial whether abnormal FV compromises the postoperative outcomes of hip arthroscopic surgery[8,14] or not.[15,18,23] Given the controversies over the influence of abnormal FV, we aimed to compare the clinical outcomes of hip arthroscopic surgery for FAI or labral tears between patients with normal FV and those with abnormal FV. We hypothesized that abnormal FV would influence the clinical outcomes of hip arthroscopic surgery for FAI or labral tears.

METHODS

The current systematic review was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist.[31] A comprehensive search of the literature was conducted using PubMed, Embase, and the Cochrane Library in July 2020. Keywords included femoral version, femoral anteversion, femoral retroversion, femoral torsion, femoral antetorsion, femoroacetabular impingement, labr*, and hip arthroscop*. Reference lists of related systematic reviews were also evaluated.

Study Selection

The first 2 authors (C.W. and Y.S.) independently assessed all the titles and abstracts for relevance. If the data were insufficient, full texts were retrieved for judgement. All references of enrolled studies were also examined. In case of disagreement on the inclusion of studies, the corresponding author (J.C.) reviewed them to resolve inconsistencies.

Inclusion and Exclusion Criteria

Inclusion criteria were the following: (1) participants were patients diagnosed with FAI or labral tears whose degree of FV was recorded; (2) the intervention was hip arthroscopic surgery; (3) the postoperative outcomes of patients with normal FV and abnormal FV were reported and compared; and (4) the outcome of postoperative recovery, indicated by functional scales, subjective scales, or range of motion, was reported with a minimal follow-up of at least 1 year.

Studies were excluded for the following reasons: (1) information on the judgement of FV was insufficient; (2) only patients with normal or abnormal FV were included; (3) they were nonclinical studies; (4) they were case reports, reviews, systematic reviews (with or without meta-analysis), unpublished manuscripts, commentaries, editorials, lectures, meeting abstracts, and so on; (5) they included a duplicate population; and (6) they were studies in which detailed recovery data of FAI or labral tears could not be extracted from a mixed population with disorders except for FAI or labral tears.

Data Extraction

The first 2 authors (C.W. and Y.S.) independently extracted data from eligible studies, including the year of publication, type of study and level of evidence, number of patients, mean age at surgery, mean duration of follow-up, degree of FV, surgical technique, radiographic findings (including lateral center-edge angle [LCEA], alpha angle, and anterior center-edge angle), and preoperative and postoperative clinical scores.

The primary outcome was the modified Harris Hip Score (mHHS), which included the postoperative value and the improvement in the score (Δ). Secondary outcomes included the Hip Outcome Score–Sport-Specific Subscale (HOS-SSS), Non-Arthritic Hip Score (NAHS), visual analog scale (VAS), failure rate, and patient satisfaction.

Quality Assessment

The quality of each included study was assessed by the first 2 authors (C.W. and Y.S.) using the Newcastle-Ottawa Scale,[48] which was designed for rating the quality of nonrandomized controlled trials using a score between 1 and 9.

Data Analysis

For comparisons of basic characteristics, the Student t test or 1-way analysis of variance was conducted using SPSS software (Version 18.0; IBM Corp). For comparisons of primary and secondary outcomes, a random-effects model was used with Review Manager (Version 5.3; Cochrane Collaboration). A 2-tailed P value $<.05$ was regarded as statistically significant. Differences in primary and secondary outcomes were measured using the mean difference (MD) or odds ratio and 95% confidence interval (CI) when appropriate. For cases in which the standard deviation of the Δ value was not reported, a correlation of 0.5 was used to estimate the dispersion. Heterogeneity was assessed using the Q statistic and I^2 statistic. Comparisons with an I^2

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value >50% were considered to have significant heterogeneity.[21]

Subgroup analysis was conducted based on FV reported by individual articles: that is, normal version,[14,26,42] retroversion,[14,18] and anteversion.[8,15,23] Subgroup analysis showing a statistically significant test of interaction ($P < .05$) provided evidence that the intervention effect may depend on the subgroup.[45] A potential source of significant heterogeneity was detected using sensitivity analysis. Because of the limited number of studies included, publication bias was not detected.[44]

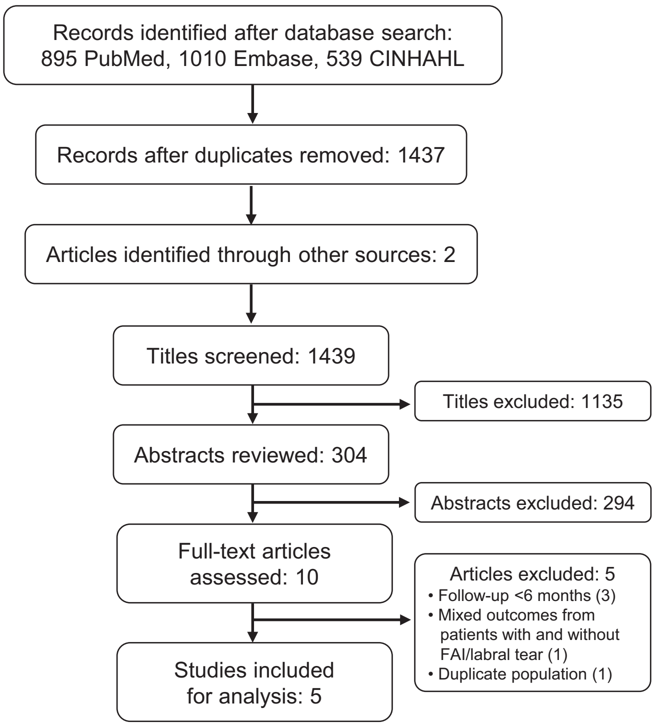

Figure 1. Flowchart of the study inclusion process. FAI, femoroacetabular impingement.

RESULTS

Studies Included

The initial search yielded 1437 articles, and 10 full-text articles were retrieved for further screening. After screening, we included 3 level 3 studies,[8,18,23] 1 level 4 study,[15] and 1 level 2 study,[14] all of which were published between 2015 and 2019 (Figure 1). All 5 studies achieved scores no less than 6 according to the Newcastle-Ottawa Scale. Characteristics of the included studies are shown in Table 1.

Study Population

The pooled patient characteristics at baseline are shown in Table 2. A total of 822 patients who underwent arthroscopic surgery for FAI or labral tears were included in the 5 studies, with 166 patients in the retroversion group, 512 in the normal version group, and 144 in the anteversion group. Furthermore, 4 studies[8,15,18,23] used magnetic resonance imaging (MRI), and 1 study[14] used computed tomography (CT) to measure FV. The definitions of retroversion, normal version, and anteversion were different across studies. In the included patient population, the median follow-up was 28.4 months, with similar follow-up periods among the 3 groups.

TABLE 1
Characteristics of the Included Studies[a]

Lead Author (Year)	LOE	Definition of FV	FV Measurement Method	Diagnosis	No. of Patients	Outcomes	NOS Score
Jackson[23] (2015)	3	R: <–2° N: –2°-18° A: >18°	MRI	Labral tear with or without FAI	R: 22 N: 196 A: 27	mHHS, NAHS, HOS-SSS, VAS for pain, satisfaction, HOS-ADL	6
Ferro[15] (2015)	4	R: <5° N: 5°-15° A: >15°	MRI	FAI and labral tear	R: 48 N: 84 A: 48	mHHS, WOMAC, SF-12	6
Fabricant[14] (2015)	2	R: <5° N: 5°-20° A: >20°	Low-dose CT	FAI	R: 37 N: 149 A: 57	mHHS, HOS-ADL, HOS-SSS, iHOT-33, ROM	7
Hartigan[18] (2017)	3	R: <0° N: 10°-20°	MRI	FAI and labral tear	R: 59 N: 59 A: —	mHHS, NAHS, HOS-SSS, VAS for pain	7
Chaharbakhshi[8] (2019)	3	N: 5°-19° A: ≥20°	MRI	Labral tear	R: — N: 24 A: 12	mHHS, NAHS, HOS-SSS, iHOT-12, VAS for pain, satisfaction	6

[a]A, anteversion; CT, computed tomography; FAI, femoroacetabular impingement; FV, femoral version; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool–12; iHOT-33, International Hip Outcome Tool–33; LOE, level of evidence; mHHS, modified Harris Hip Score; MRI, magnetic resonance imaging; N, normal version; NAHS, Non-Arthritic Hip Score; NOS, Newcastle-Ottawa Scale; R, retroversion; ROM, range of motion; SF-12, Short Form–12; VAS, visual analog scale; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

TABLE 2
Pooled Patient Characteristics at Baseline[a]

	All (n = 822)	Retroversion (n = 166)	Normal Version (n = 512)	Anteversion (n = 144)	*P*
Male sex, % (n/N)	39.3 (252/642)	36.4 (43/118)	39.5 (169/428)	41.7 (40/96)	.728
Left side affected, % (n/N)	45.3 (263/581)	46.9 (45/96)	46.1 (185/401)	39.3 (33/84)	.488
Age at surgery, mean ± SD, y	34.4 ± 12.9	34.6 ± 12.8	34.7 ± 13.0	32.8 ± 12.7	.285
Follow-up, median (range), mo	28.4 (21.0-37.9)	29.6 (21.0-37.6)	28.6 (21.0-37.9)	30.3 (21.0-32.3)	—
Body mass index, mean ± SD	24.3 ± 4.0	25.1 ± 4.0	24.1 ± 4.0	24.0 ± 4.1	.096

[a]Dash indicates the *P* value need not or cannot be caculated.

TABLE 3
Surgical Procedures by Version Type[a]

	Sample Size, n	Retroversion	Normal Version	Anteversion
Labral debridement	150	26 (17.3)	111 (74.0)	13 (8.7)
Labral repair	398	92 (23.1)	239 (60.1)	67 (16.8)
Labral reconstruction	31	10 (32.3)	13 (41.9)	8 (25.8)
Capsular repair	202	43 (21.3)	136 (67.3)	23 (11.4)
Acetabuloplasty	123	50 (40.6)	68 (55.3)	5 (4.1)
Femoroplasty	287	97 (33.8)	139 (48.4)	51 (17.8)
Ilioplasty release	172	35 (20.4)	107 (62.2)	30 (17.4)
Iliopsoas fractional lengthening	21	0 (0.0)	14 (66.7)	7 (33.3)
Ligamentum teres debridement	237	66 (27.9)	116 (48.9)	55 (23.2)

[a]Data are reported as n (%) unless otherwise indicated.

TABLE 4
Radiographic Findings of Included Studies[a]

	All		Retroversion		Normal Version		Anteversion		
	No. of Patients	Mean ± SD	No. of Patients	Mean ± SD	No. of Patients	Mean ± SD	No. of Patients	Mean ± SD	*P*
LCEA									
Preoperative	307	30.4 ± 5.5	107	30.1 ± 5.6	143	30.4 ± 5.5	57	31.0 ± 4.7	.597
Postoperative	118	28.7 ± 4.8	59	29.0 ± 4.7	59	28.3 ± 4.9	—	—	.430
ACEA									
Preoperative	118	29.7 ± 8.6	59	28.5 ± 10.4	59	30.8 ± 6.2	—	—	.530
Postoperative	118	30.7 ± 6.9	59	30.8 ± 6.6	59	30.5 ± 7.3	—	—	.815
Alpha angle									
Preoperative	541	62.6 ± 10.9	144	62.0 ± 11.5	292	62.9 ± 10.7	105	62.5 ± 9.0	.634
Postoperative	118	43.9 ± 7.8	59	44.7 ± 8.7	59	43.0 ± 6.8	—	—	.234

[a]Dashes indicate the *P* value need not or cannot be caculated. ACEA, anterior center-edge angle; LCEA, lateral center-edge angle.

Surgical Procedures

In this review, 4 studies[8,15,18,23] reported operative techniques. The surgical procedures and corresponding number of patients treated are shown in Table 3.

Radiographic Findings

Radiographic findings of the included studies are shown in Table 4. No significant difference was found in terms of the preoperative LCEA, anterior center-edge angle, and alpha angle among the 3 groups. Postoperatively, there was no significant difference between the retroversion and normal version groups in terms of the 3 angles. A comparison of postoperative values between the anteversion and normal version groups could not be conducted because of a lack of data.

Primary Outcome

Figure 2 demonstrates the difference in postoperative mHHS scores in the retroversion and anteversion groups compared with the normal version group. The retroversion group had similar postoperative mHHS scores to those of the normal version group (3 studies; MD, 2.42 [95% CI, −3.42 to 8.26]; $P = .42$), with significant heterogeneity

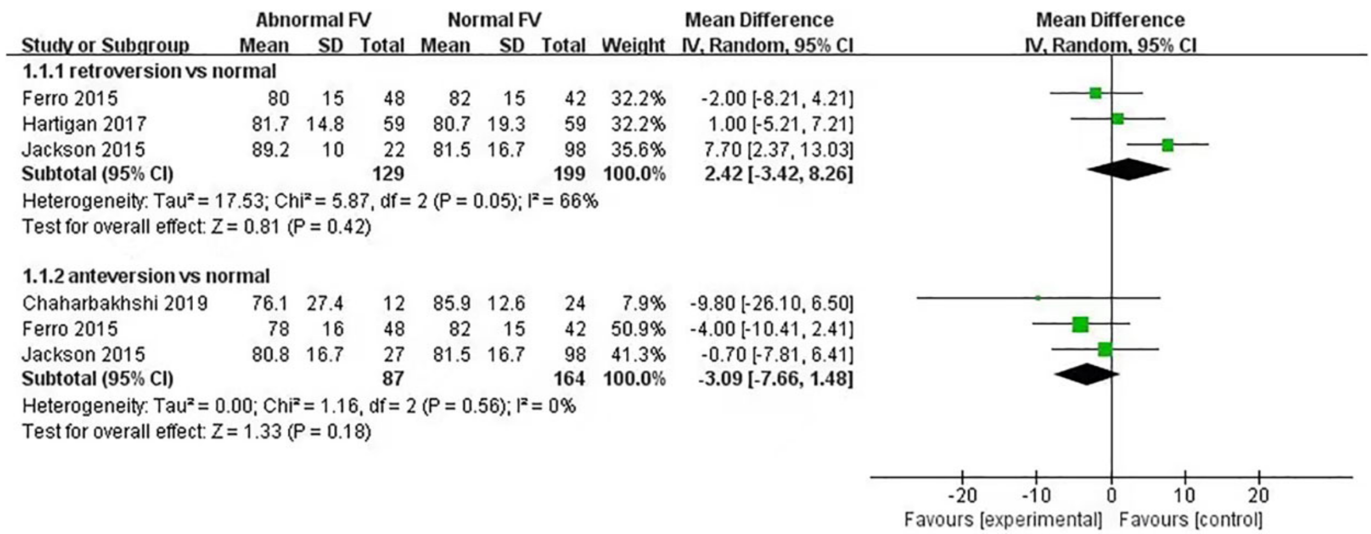

Figure 2. Forest plot of the postoperative modified Harris Hip Score. FV, femoral version; IV, inverse variance.

TABLE 5
Pooled Results[a]

	Mean Difference (95% CI)	P	I^2, %	P
Retroversion vs normal version				
Postoperative mHHS	2.42 (–3.42 to 8.26)	.42	66	.05
ΔmHHS	–0.70 (–8.56 to 7.15)	.86	75	.02
Postoperative NAHS	5.96 (1.66 to 10.26)	**.007**	0	.51
ΔNAHS	3.79 (–1.66 to 9.24)	.17	0	.35
Postoperative HOS-SSS	7.32 (0.19 to 14.44)	**.04**	0	.46
ΔHOS-SSS	–2.61 (–15.72 to 10.50)	.70	78	.01
Postoperative VAS for pain	–0.13 (–0.77 to 0.51)	.69	0	.44
ΔVAS	–0.13 (–0.87 to 0.60)	.72	0	.43
Patient satisfaction	–0.20 (–1.49 to 1.09)	.76	—	—
Failure rate	0.56 (0.18 to 1.77)	.32	0	.91
Anteversion vs normal version				
Postoperative mHHS	–3.09 (–7.66 to 1.48)	.18	0	.56
ΔmHHS	–1.92 (–6.18 to 2.34)	.38	0	.93
Postoperative NAHS	–4.39 (–19.27 to 10.49)	.56	70	.07
ΔNAHS	–2.35 (–8.23 to 3.53)	.43	0	.62
Postoperative HOS-SSS	–6.49 (–29.12 to 16.13)	.57	70	.07
ΔHOS-SSS	–2.44 (–12.25 to 7.37)	.63	0	.48
Postoperative VAS for pain	–0.09 (–1.29 to 1.47)	.90	41	.19
ΔVAS	–0.19 (–2.11 to 1.74)	.85	71	.07
Patient satisfaction	–0.11 (–1.95 to 1.73)	.91	72	.06
Failure rate	0.70 (0.25 to 1.91)	.48	0	.36

[a]Bolded P values indicate a statistically significant difference between groups ($P < .05$). Dashes indicate the P value need not or cannot be caculated.HOS-SSS, Hip Outcome Score–Sport-Specific Subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; VAS, visual analog scale.

(I^2 = 66%; P = .05) (Table 5). Subsequently, sensitivity analysis was conducted and found that the study by Jackson et al[23] was the origin of heterogeneity. After excluding this study, the pooled results showed no significant difference between the retroversion and normal version groups (2 studies; MD, –0.50 [95% CI, –4.89 to 3.89]; P = .82), without significant heterogeneity (I^2 = 0%; P = .50). The anteversion and normal version groups had no significant difference in postoperative mHHS scores (3 studies; MD, −3.09 [95% CI, –7.66 to 1.48]; P = .18); heterogeneity was not significant (I^2 = 0%; P = .56) (Table 5).

Figure 3 demonstrates the difference in ΔmHHS scores between the retroversion and anteversion groups compared with the normal version group. Similar ΔmHHS scores were seen for retroversion and normal version (3 studies; MD, –0.70 [95% CI, –8.56 to 7.15]; P = .86), with significant heterogeneity (I^2 = 75%; P = .02) (Table 5).[8,14,15] Sensitivity analysis to detect the origin of heterogeneity indicated that the study by Fabricant et al[14] was the origin of heterogeneity in ΔmHHS scores. After excluding this study, the pooled results indicated that the difference in ΔmHHS scores between retroversion and normal version was not significant (3 studies; MD, 3.31 [95% CI, –1.61 to 8.23]; P = .19), with insignificant heterogeneity (I^2 = 0%; P = .49).[8,15] The anteversion group had no significant difference compared with the normal version group regarding ΔmHHS scores (3 studies; MD, −1.92 [95% CI, –6.18 to 2.34]; P = .38), with no significant heterogeneity (I^2 = 0%; P = .93) (Table 5).[18,23]

Secondary Outcomes

Compared with the normal version group, the retroversion group had a significant difference in postoperative NAHS scores (2 studies; MD, 5.96 [95% CI, 1.66-10.26]; P = .007), with no significant heterogeneity (I^2 = 0%; P = .51), and a significant difference in postoperative HOS-SSS scores (2 studies; MD, 7.32 [95% CI, 0.19-14.44]; P = .04), with no significant heterogeneity (I^2 = 0%; P = .46).[8,18] The normal version group had no significant difference from the

Study or Subgroup	Abnormal FV Mean	Abnormal FV SD	Abnormal FV Total	Normal FV Mean	Normal FV SD	Normal FV Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 retroversion vs normal								
Fabricant 2015	14	16.5	37	22	15.6	74	34.4%	-8.00 [-14.40, -1.60]
Hartigan 2017	15.4	21.2	59	14.1	20.6	59	31.5%	1.30 [-6.24, 8.84]
Jackson 2015	24.7	13.3	22	19.9	17	98	34.1%	4.80 [-1.70, 11.30]
Subtotal (95% CI)			**118**			**231**	**100.0%**	**-0.70 [-8.56, 7.15]**
Heterogeneity: Tau² = 36.12; Chi² = 8.02, df = 2 (P = 0.02); I² = 75%								
Test for overall effect: Z = 0.17 (P = 0.86)								
1.2.2 anteversion vs normal								
Chaharbakhshi 2019	18.3	23.8	12	22.8	14	24	8.5%	-4.50 [-19.08, 10.08]
Fabricant 2015	20	18.9	57	22	15.6	75	49.6%	-2.00 [-8.04, 4.04]
Jackson 2015	18.6	15	27	19.9	17	98	41.8%	-1.30 [-7.88, 5.28]
Subtotal (95% CI)			**96**			**197**	**100.0%**	**-1.92 [-6.18, 2.34]**
Heterogeneity: Tau² = 0.00; Chi² = 0.15, df = 2 (P = 0.93); I² = 0%								
Test for overall effect: Z = 0.88 (P = 0.38)								

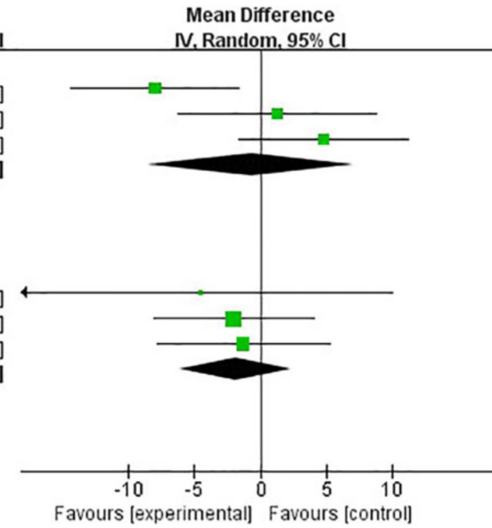

Figure 3. Forest plot of the ΔmHHS. FV, femoral version; IV, inverse variance; mHHS, modified Harris Hip Score.

retroversion group or anteversion group in postoperative VAS, ΔNAHS, ΔHOS-SSS, and ΔVAS scores as well as patient satisfaction and failure rates (Table 5). Detailed forest plots of the aforementioned outcomes are provided separately as supplemental material.

DISCUSSION

To our knowledge, this is the first meta-analysis comparing the outcomes of hip arthroscopic surgery for FAI or labral tears in patients with and without abnormal FV. The primary outcome was the mHHS, and the secondary outcomes were the NAHS, HOS-SSS, VAS for pain, failure rate, and patient satisfaction. Except for the significant difference in postoperative NAHS and HOS-SSS scores between retroversion and normal FV, the pooled results of 5 studies showed that abnormal FV did not influence functional scores, patient satisfaction, or failure rates after hip arthroscopic surgery for FAI or labral tears.

FV is defined as rotation of the femoral neck axis around the femoral shaft in the transverse plane,[20] and studies have used radiography,[11] ultrasound,[6] CT,[19,24] and MRI[20,41] to evaluate FV. Although CT is widely used, it has been proven recently that FV can be effectively measured using MRI,[4,5,20,41] which was used in 4 studies of this review.[8,15,18,23] FV is measured as the angle between the proximal axis through the femoral neck and head to the distal reference line.[7,16,20,35,41,46] While the definition of the distal reference line as a line connecting the dorsal border of the 2 femoral condyles is consistent,[5,20,27,35,36] the definition of the proximal femoral axis varies.[8,14,15,18,23] In this review, the proximal femoral axis was defined differently among the 5 included studies. It should be noted that this variation in the definition may result in different FV values, even in the same sample.[5,20,25,40] Ito et al[22] defined normal FV as 5° to 20° on MRI scans, which is widely accepted,[5,35,36,46] but the definition of abnormal FV still remains controversial.[8,14,15,18,23] In this review, retroversion was defined as FV <–2°,[23] <0°,[18] or <5°,[14,15] and anteversion was defined as FV >15°,[15] >18°,[23] or >20°.[8,14]

Femoral retroversion has been reported to be associated with cam-type FAI[22] and limited hip internal rotation, which could result from a reduction of the femoral head-neck offset.[22,47] Tönnis and Heinecke[47] reported that femoral retroversion could lead to limited internal rotation because decreased clearance of the femoral neck would bring the anterior femoral head closer to the acetabulum during hip flexion. Besides intra-articular FAI, extra-articular subspine impingement has also been reported to be more prevalent in hips with decreased FV.[1,29] Theoretically, extensive cam osteoplasty in patients with FAI and femoral retroversion should be performed to further increase the anterior femoral head-neck offset.[22] In this review, 1 study[14] reported that the retroversion group had greater internal rotation improvements than did the normal version group, which might indicate deeper osteoplasty in the retroversion group. However, the included studies in this review did not report any special technique of cam osteoplasty in the retroversion group.

On the other hand, increased femoral anteversion is supposed to be correlated with hip impingement,[17,42] hip instability,[32,38,39] and labral tears.[9,12,34,49] Femoral anteversion leads to increased internal rotation and limited external rotation of the hip[47] and might result in both intra-articular and extra-articular impingement.[17,42] In our review, an included study[15] also reported that patients with femoral anteversion had increased internal rotation ($P = .005$) and decreased external rotation ($P = .031$) compared with those with femoral retroversion and normal version. With femoral anteversion, hip impingement might occur between the femoral neck and rim during hip extension and external rotation,[3] between the greater trochanter and pelvis during hip flexion and external rotation,[3] and between the lesser trochanter and ischium.[17] In addition, femoral anteversion results in insufficient anterior femoral head coverage and leads to hip instability, especially in hips with developmental dysplasia.[32,38,39] One of the included studies in this review reported that patients with combined FV ≥20° and borderline dysplasia (LCEA, 18°-25°) had significantly inferior postoperative mHHS, NAHS, and HOS-SSS scores as well as patient satisfaction compared with the control group with normal FV and without dysplasia.[8] Given the results of this study, patients with suspected borderline dysplasia should be evaluated for femoral anteversion before recommendation for an arthroscopic intervention. In addition, femoral anteversion might be a risk factor for lengthening surgery of the psoas tendon, which contributes to hip anterior stability.[13] It has been reported that patients with excessive femoral anteversion (>25°) undergoing arthroscopic psoas tendon lengthening had significantly lower postoperative mHHS scores than did the patients with normal or decreased FV.[13] Moreover, femoral anteversion has been proven to be associated with labral tears.[9,12,34,49] A previous study[12] reported that hips with femoral anteversion had a higher incidence of anterior labral tears than did those with normal FV, which might be a negative predictor of outcomes, especially hip pain and activities of daily living.[15]

In our study, neither retroversion nor anteversion was found to significantly undermine the outcome regarding postoperative mHHS or ΔmHHS scores. Nevertheless, significant heterogeneity was detected in terms of postoperative mHHS and ΔmHHS scores between the normal version group and the retroversion group. Sensitivity analysis indicated that the heterogeneity of postoperative mHHS scores was introduced by Jackson et al,[23] while the heterogeneity of ΔmHHS scores was introduced by Fabricant et al.[14] There are several potential reasons for this inconsistency. First, more than one-fifth of the patients included in the study of Jackson et al[23] underwent iliopsoas lengthening, which was not included in the other studies. Second, retroversion was defined as FV <–2° by Jackson et al,[23] which was a stricter definition than that given by the other 3 studies (FV <0° in 1 study and <5° in 2 studies).[14,15,18] Third, among the studies that compared ΔmHHS scores between normal version and retroversion, only Fabricant et al[14] used CT to measure FV instead of MRI, as in the other studies.[8,14,15,18] Considering that FV measured on CT scans could be larger than that on MRI scans,[5,20] this discrepancy might be a source of heterogeneity.

Regarding the controversy on the influence of anteversion among the included studies, no significant heterogeneity was detected. By checking the reported data, we found that the postoperative mHHS score reported by Chaharbakhshi et al[8] did not reach statistical difference between normal version and anteversion, which was in disagreement with their calculation ($P = .005$). Although a significant difference was found between the retroversion and normal version groups in postoperative NAHS and HOS-SSS scores, most of the secondary outcomes in the patients with abnormal FV were similar to those in the patients with normal FV. To sum up, neither retroversion nor anteversion significantly weakened postoperative function or postoperative improvement, which was supported by our calculations for secondary outcomes.

This systematic review has several limitations. First, considering that Botser et al[5] found an MD of 8.9° for FV between CT and MRI measurements, FV evaluated using different techniques in this review might result in a difference in FV values. Second, the various definitions of the proximal femoral axis in the studies might also have led to different FV values. Third, some of the data used for meta-analysis were calculated based on estimation, and the data on each FV group remained limited, which could also have introduced uncertainty into the pooled outcomes. Fourth, although no significant difference was found in radiographic data, the majority of radiographic findings was from the study by Hartigan et al,[18] which only included 59 patients each in the normal version and retroversion groups. Fifth, the percentage of patients who underwent the same surgical procedures was different among the included studies, which might have introduced heterogeneity to the outcomes.

CONCLUSION

Based on the current systematic review and meta-analysis, abnormal FV, including retroversion and anteversion, did not affect the outcomes of hip arthroscopic surgery for FAI and labral tears compared with normal version. A higher level of evidence is still required to support our findings.

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