Journal of Hip Preservation Surgery Vol. 5, No. 3, pp. 190–201
doi: 10.1093/jhps/hny029
Advance Access Publication 17 August 2018
Review article

OXFORD

A systematic review—meta-analysis of venous thromboembolic events following primary hip arthroscopy for FAI: clinical and epidemiologic considerations

Ioanna K. Bolia[1], Lorenzo Fagotti[1], Shannen McNamara[1], Grant Dornan[1], Karen K. Briggs[1] and Marc J. Philippon[1,2]*

[1]Department of Hip Research, Steadman Philippon Research Institute and
[2]Department of Hip Research, The Steadman Clinic, 181 W. Meadow Dr. 81657 Vail, CO, USA
*Correspondence to: M. J. Philippon. E-mail: drphilippon@sprivail.org
Submitted 31 January 2018; revised version accepted 8 July 2018

ABSTRACT

The purpose of this study was to report the proportion of venous thromboembolic events (VTE) in patients undergoing primary hip arthroscopy for femoroacetabular impingement (FAI) and present a critical overview of the literature to aid in better result interpretation. MedLine, Scopus and Web of Science databases were searched from January 2000 to March 2017. Four thousand-five-hundred and seventy-seven hip cases were included in the meta-analysis of 38 studies. The mean age of patients was 36 ± 1.8 years and the mean follow-up time was 20.6 months. The meta-analysed rate of deep vein thrombosis (DVT) in patients undergoing primary hip arthroscopy for FAI syndrome was 1.18%; 95%CI [0.8–1.74%]; The meta-analysed rate of pulmonary embolism (PE) in patients undergoing primary hip arthroscopy for FAI syndrome was 0.59%; 95%CI [0.38–0.92%]. Quality assessment was performed using the Methodological Index for Non-Randomized Studies (MINORS) criteria the Quality in Prognostic Studies (QUIPS) tool. Sensitivity analysis was conducted to assess for publication bias and its influence on the results. The corrected for publication bias proportion of DVT was 2.02%; 95%CI [1.36–2.99%]. The DVT rate was double following the correction of bias while additional types of bias were detected. Attention must be paid when considering the outcomes of observational studies to make clinical decisions. Insufficient evidence exists to support whether anti-VTE chemoprophylaxis should be administered to patients undergoing primary hip arthroscopy for FAI. Due to the life-threatening character of this complication, the results should serve as starting point to design clinical trials and establish guidelines. Until then, the application of preventive measures against VTE should be decided on a case-by-case basis.

INTRODUCTION

Hip arthroscopy has advanced over the years, and its indications have expanded. The number of post-operative complications has increased accordingly [1, 2]. Commonly reported complications following hip arthroscopy include nerve injury, iatrogenic chondrolabral injury, skin damage, infection, avascular necrosis of the femoral head, hip dislocation, femoral neck fracture, heterotopic ossification, intra-abdominal or intra-thoracic fluid extravasation and venous thromboembolic events (VTE) including deep vein thrombosis (DVT) and pulmonary embolism (PE) [3, 4]. A blood clot, which is commonly formed in the deep venous system of the lower limb, may subsequently get wedged into to the pulmonary artery or its branches and lead to compromise of the pulmonary blood supply which sometimes leads to patient's death.

Orthopaedic surgical procedures may carry increased risk for the development of VTE due to temporary endothelial dysfunction at the operation site, venous stasis as a result of patient immobilization during the recovery period and

possible hypercoagulability state which is also patient dependent [5]. According to the American College of Chest Physicians (ACCP), there is no validated tool to assess individual risk factors and their contribution to the development of VTE in patients undergoing orthopaedic procedures [6]. These factors may include previous VTE, cardiovascular disease, Charlson comorbidity index ≥ 3, body mass index (BMI) $> 25\,kg/m^2$, age (OR, 1.1 for each 5-year increment versus age < 40 years), advanced age $\geq$ 85 years, varicose veins and ambulation before day 2 after surgery [6]. Apart from patient factors, it is unknown if hip arthroscopy carries increased risk for the development of VTE compared to knee arthroscopy where routine anti-VTE chemoprophylaxis is not recommended. An arthroscopic hip procedure includes foot and ankle immobilization, use of traction, surgical manoeuvres performed in proximity to the deep femoral vein system where thrombi can form and usually spinal or epidural anaesthesia which causes venodilation and blood stasis [7, 8].

Rationale

Different types studies have reported the incidence of VTE following hip arthroscopy, and significant result variability exists [21, 22]. The reported VTE rate in case series studies ranges from 0% to 7%, which includes both symptomatic and asymptomatic cases [9–13]. Previous systematic reviews have reported the proportion of DVT/PE following hip arthroscopy to be less than 0.5%, but numerous types of post-hip arthroscopy complications were studied alongside [3, 4]. A recent systematic review focused exclusively on the VTE rate following hip arthroscopy for FAI and compared the proportion of VTE in patients with versus without administration of VTE chemoprophylaxis. The reported a rate of VTE was approximately 2% in both groups. All the above studies did not differentiate between patients with previous hip procedures, pre-existing hip disease (such as avascular necrosis of the femoral head, pigmented villonodular synovitis, etc.) or those where hip arthroscopy was combined with other procedures. The last may include endoscopic gluteus tendon repair, trochanteric bursectomy, psoas tenotomy or open hip procedures. Although no evidence exists for the influence of these factors on the incidence of VTE complications following arthroscopic FAI surgery, these parameters could serve as confounders when calculating the proportion of VTE.

The purpose of this study was to report the meta-analysed rates of DVT and PE following primary hip arthroscopy for FAI in low risk patients based on observational studies, and provide a critical overview of current evidence to aid the interpretation of the results and support clinical practice.

MATERIALS AND METHODS

This study was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Search strategy

Three reviewers (IKB, LF, SM) searched three online databases (MedLine, Scopus and Web of Science) for relevant articles. Search strings were applied to all databases including: timeline constraints from 2000 to 2017; case-control study; cohort study; comparative studies; observational study; journal article; article in English language. The following keywords were used in all three databases: DVT hip arthroscopy; PE hip arthroscopy; venous thromboembolism hip arthroscopy; complications hip arthroscopy; DVT femoroacetabular impingement (FAI); PE FAI; venous thromboembolism FAI. Hand searching was conducted by 1 reviewer to retrieve additional pertinent articles.

Inclusion and exclusion criteria

The inclusion criteria were (1) non-randomized prospective and retrospective observational studies reporting whether any complication was observed during the follow-up period and/or the rate of complications and/or the proportion of VTE following hip arthroscopy, (2) articles in English with full text availability, (3) articles published in peer reviewed journals from January 2000 to March 2017, (4) studies where the patients who had previous hip surgery were excluded or it was possible to exclude them manually after reviewing the article, (5) studies where the indication for hip arthroscopy was reported. The exclusion criteria were (1) studies where the rate of DVT/PE following hip arthroscopy was not reported, (2) studies where the complications following hip arthroscopy were not reported, (3) non-English articles, (4) different studies that were conducted on the same patient population (the study with the largest patient population was included), (5) studies where the indication for hip arthroscopy was other than FAI, (6) studies on patients younger than 18 years of age, (7)studies conducted using national or international databases. Two reviewers applied the study criteria and a third reviewer was consulted in cases of disagreement.

Search results

Four hundred fifty-two studies were retrieved from the electronic search of the three databases. The title and abstract screening of 131 articles yielded 101 articles that were eligible for full text screening. We finally included 73 studies; 38 in the quantitative synthesis (meta-analysis)

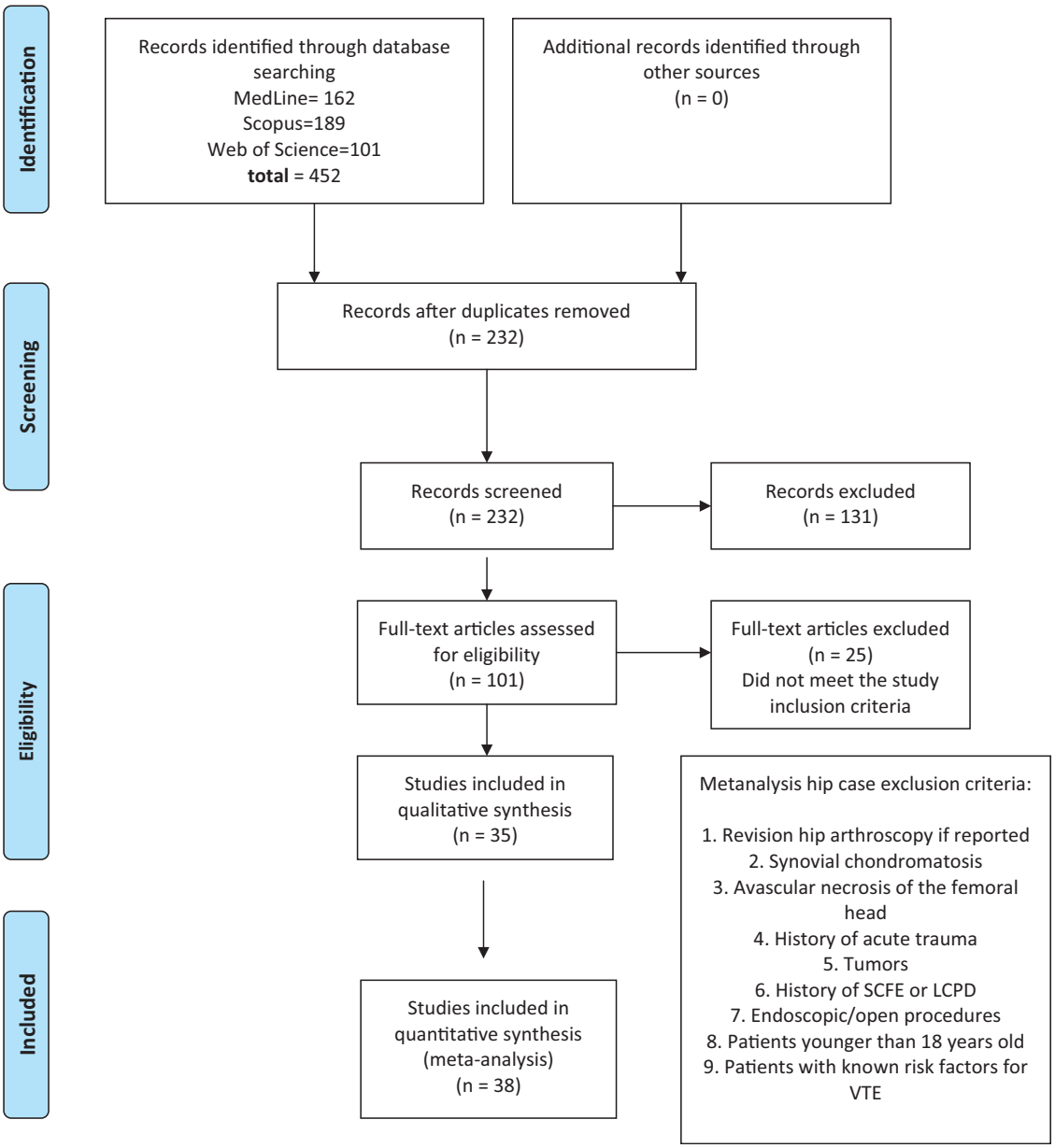


Fig. 1. PRISMA flowchart.

and 35 in the qualitative synthesis of this systematic review (Fig. 1).

Study quality assessment

For the articles included in the meta-analysis quality assessment was performed using the Methodological Index for Non-Randomized Studies (MINORS) criteria and the risk of bias assessment was conducted using the Quality in Prognostic Studies (QUIPS) tool (Cochrane methods). Both evaluation tools were applied by two reviewers and a third reviewer was consulted in cases of disagreement. The inter-reviewer agreement at all stages of study screening (title, abstract, full text) was assessed by calculating the *k* value. Confounding (27 studies, 67.5%) and attrition bias (10 studies, 25%) were the two most commonly observed types of bias in the meta-analysed articles, Table II). Prognostic factor measurement was partially reported in 18 studies (18/40, 45%). Most studies had satisfactory outcome measurement methods, statistical analysis and reporting rates. The mean MINORS score was 13.4 ± 2.8 points (range: 9–20) indicating a fair quality of evidence. At all three stages of article screening the *k* value was

higher than 0.60 which indicates substantial agreement between the reviewers' evaluation.

Data collection and abstraction

Spreadsheets were used for data extraction by the primary author. A second author (SM) evaluated and verified the data accuracy. In cases of disagreement a third reviewer was consulted. Patient demographics (age, gender), preoperative diagnosis, history of hip disease or previous surgery, any risk factors reported to predispose to VTE, the anti-thrombotic prophylaxis measures, the type of anaesthesia used during the operation and the number and type of VTE complications were recorded for each study.

Meta-analysis and investigation for publication bias

Hip case inclusion-exclusion criteria were applied in each meta-analysed article to improve the homogeneity of the study population. Hip arthroscopy cases were included if no previous procedures had been performed on the same hip and if the indication for hip arthroscopy was FAI. Hip cases were excluded if there was history of previous surgery, avascular necrosis of the femoral head (AVN), pigmented villonodular synovitis, acute traumatic labral tears or cartilage defects, slipped capital femoral epiphysis (SCFE), Legg-Calve-Perthes Disease (LCPD) and if the hip arthroscopic procedure was performed in combination with endoscopic (gluteus medius pathology, trochanteric bursitis, sciatic nerve decompression) or open hip surgery. In addition, high risk patients who developed VTE complication following hip arthroscopy were not included in the meta-analysis.

To allow for generalizability of the results beyond the set of included studies, random-effects meta-analysis was used. Residual heterogeneity was estimated using the DerSimonian-Laird method, reported using the I2 statistic and presented with 95% confidence intervals. Evidence for publication bias was assessed using funnel plots and symmetry was tested using the rank correlation test. The statistical software R version 3.3.2 was used to produce all analyses and results figures (R, R Foundation for Statistical Computing with additional packages meta and metafor).

RESULTS

Four thousand five hundred and seventy-seven hip cases were included in the meta-analysis of 38 studies. The mean age of patients was 36 ± 1.8 years and the mean follow-up time was 20.6 months. The meta-analysed rate of DVT in low risk patients undergoing primary hip arthroscopy for FAI was 1.18%; 95%CI [0.8–1.74%]; The meta-analysed rate of PE in low risk patients undergoing primary hip arthroscopy for FAI was 0.59%; 95%CI [0.38–0.92%].

Epidemiologic analysis

Most included articles were of level of evidence IV (27/38, 71%). Five studies (13%) were of level of evidence III and 6 studies (16%) were of level II of evidence. Whether or not anti-VTE prophylaxis was used in patients undergoing primary hip arthroscopy for FAI and the type of measures taken to avoid this complication were significantly underdocumented. Most articles (23/38, 60.5%) did not report whether anti-VTE was used. Five studies (13.1%) did not recommend any type of anti-VTE prophylaxis, while mechanical prophylaxis (compression device) and chemoprophylaxis were recommended in five studies (13.1%) and five studies (13.1%), respectively (Table I).

Table II presents the different types and distribution of bias among the meta-analysed studies as identified using the QUIPS tool. Confounding (23/38, 60.5%) and attrition bias (25/38, 65.7%) were most commonly observed.

Regarding the estimation of the DVT rate, the study heterogeneity ($I2$) was 29.3%; 95%CI [0–52%]. Rank test for funnel plot asymmetry (Fig. 2) was significant (Kendall's tau= 0.4499), $P < 0.001$), thus we had evidence for possible publication bias. The last means that small studies with low DVT rates were more likely to be published than larger studies with low DVT rates. The corrected for publication bias proportion of DVT was 2.02%; 95% CI [1.36–2.99%], which shows that publication bias significantly affected the result.

The rank test for funnel plot asymmetry was not significant (Kendall's tau = 0.9364, $P > 0.001$) when investigating the PE rate, thus no publication bias was observed in this case. The study heterogeneity $I2$ was 0%. In conclusion, no sufficient data are available to guide the clinical practice on the use of routine chemoprophylaxis against VTE in low-risk patients undergoing primary hip arthroscopy for FAI.

DISCUSSION

Limitations

The main limitation of this study is that most of meta-analysed studies are of level IV of evidence. Furthermore, significant amount of confounding and attrition bias was detected which raises concerns regarding the validity of the results. On the other hand, the only available source of data for the calculation of the VTE rate following primary hip arthroscopy for FAI syndrome were follow-up studies. All the included studies have sufficient follow-up time to assess for the development of VTE after orthopaedic procedures as recommended by ACCP [6]. Sensitivity analysis was conducted to assess for possible publication bias which basically resulted from the analysis of retrospective and

Table I. VTE rate, type of anaesthesia and anti-VTE measures applied in meta-analysed articles

Study	*# patients (# hip cases meta-analysed)*	*DVT rate (95%CI) PE rate (95%CI)*	*Comments*	*Anti-thrombotic prophylaxis*	*Anaesthesia*
Mohtadi *et al.* [13]	120 (115)	4.35% (1.43–9.85) 0% (0–3.16%)	Doppler U/S screening 4/5 patients were symptomatic	Early mobilization	N/R
Fukushima *et al.* [12]	72 (72)	6.94% (2.29–15.47) 0% (0–4.99)	Doppler U/S screening Asymptomatic patients	No anticoagulants	General
Gupta *et al.* [16]	587 (587)	0.68% (0.19–1.74) 0.17% (0–0.95)	Clinical outcome study	N/R	N/R
Salvo *et al.* [18]	81 (76)	2.63% (0.32–9.18) 0% (0–4.74)	N/A	No chemical or mechanical prophylaxis	N/R
Chan *et al.* [19]	211 (236)	0.85% (0.1–3.03) 0% (0–1.55)	N/A	No prophylaxis	N/R
Collins *et al.* [20]	39 (39)	5.13% (0.63–17.32) 0% (0–9.03)	DVT occurred in obese patients (BMI $\geq$ 25)	acetylsalicylic acid 325 mg daily for 2 weeks	General
Alaia *et al.* [21]	139 (139)	0.72% (0.02–3.94) 0.072% (0.02–3.94)	N/A	No prophylaxis	General
Souza *et al.* [2]	194 (194)	0.52% (0.01–2.84) 0% (0–1.88)	N/A	Early mobilization	General
Awan *et al.* [22)	22 (14)	0% (0–23.16) 0% (0–23.16)	Clinical outcome study	N/R	N/R
Byrd *et al.* [9]	50 (47)	0% (0–7.55) 0% (0–7.55)	Clinical outcome study	N/R	N/R
Byrd *et al.* [23]	200 (207)	0% (0.1.77) 0% (0–1.77)	Clinical outcome study	N/R	N/R
Byrd *et al.* [24]	100 (80)	0% (0–4.51) 0% (0–4.51)	Clinical outcome study	N/R	N/R
Byrd *et al.* [25]	116 (115)	0% (0–3.16) 0% (0–3.16)	Clinical outcome study	N/R	N/R
Byrd *et al.* [26]	37 (38)	0% (0–9.25) 0% (0–9.25)	Clinical outcome study	N/R	N/R
Byrd *et al.* [27]	41 (44)	0% (0–8.04) 0% (0–8.04)	Clinical outcome study	N/R	N/R
Contreras *et al.* [28]	147 (150)	0% (0–2.43) 0% (0–2.43)	N/A	N/R	General

(continued)

Table I. (continued)

Study	*# patients (# hip cases meta-analysed)*	*DVT rate (95%CI) PE rate (95%CI)*	*Comments*	*Anti-thrombotic prophylaxis*	*Anaesthesia*
Dietrich *et al.* [10]	317 (317)	0% (0–1.16) 0% (0–1.16)	N/A	N/R	N/R
Domb *et al.* [29]	22 (21)	0% (0–16.1) 0% (0–16.1)	Clinical outcome study	N/R	N/R
Dutton *et al.* [11]	159 (159)	0% (0–2.29) 0% (0–2.29)	N/A	N/R	N/R
Flecher *et al.* [30]	23 (23)	0% (0–14.82) 0% (0–14.82)	N/A	N/R	N/R
Fukui *et al.* [31]	100 (82)	0% (0–4.40) 0% (0–4.40)	Clinical outcome study	N/R	N/R
Hartigan *et al.* [32]	78 (82)	0% (0–4.40) 0% (0–4.40)	Clinical outcome study	No DVT prophylaxis	N/R
Haviv *et al.* [33]	82 (164)	0% (0–2.22) 0% (0–2.22)	Clinical outcome study	N/R	General
Horisberger *et al.* [34]	20 (20)	0% (0–16.84) 0% (0–16.84)	Clinical outcome study	At least 2 weeks of LMWH	N/R
Javed *et al.* [35]	40 (40)	0% (0–8.81) 0% (0–8.81)	Clinical outcome study	N/R	N/R
Kamath *et al.* [36]	52 (31)	0% (0–11.22) 0% (0–11.22)	Clinical outcome study	N/R	N/R
Krych *et al.* [37)	30 (30)	0% (0–11.57) 0% (0–11.57)	Clinical outcome study	N/R	N/R
Larson *et al.* [38]	90 (94)	0% (0–3.85) 0% (0–3.85)	N/A	ASA 650/daily and/or compression stockings, early mobilization	N/R
Lo *et al.* [39]	72 (73)	0% (0–5.06) 0% (0–5.06)	N/A	N/R	General
Matsuda *et al.* [40]	140 (147)	0% (0–2.48) 0% (0–2.48)	Clinical outcome study	N/R	General
Mei Dan *et al.* [41]	122 (121)	0% (0–3.00) 0% (0–3.00)	Clinical outcome study	N/R	General
Nossa *et al.* [42]	360 (362)	0% (0–1.01) 0% (0–1.01)	N/A	Anti-thrombotic prophylaxis for 15 days	N/R

(continued)

Table I. (continued)

Study	*# patients (# hip cases meta-analysed)*	*DVT rate (95%CI) PE rate (95%CI)*	*Comments*	*Anti-thrombotic prophylaxis*	*Anaesthesia*
Palihe *et al.* [43]	150 (96)	0% (0–3.77) 0% (0–3.77)	N/A	N/R	General
Park *et al.* [44]	200 (200)	0% (0–1.83) 0% (0–1.83)	N/A	Early mobilization	General
Polat *et al.* [45]	42 (42)	0% (0–8.41) 0% (0–8.41)	Clinical outcome study	Anti-thrombotic prophylaxis	N/R
Roos *et al.* [46]	40 (41)	2.44 {0.06–12.8} 3	Clinical Outcome study	Full weight bearing allowed	N/R
Seijas *et al.* [1]	258 (258)	0% (0–1.42) 0% (0–1.42)	N/A	Enoxaparin 40 Iu/ 24 h for 10 days	Combined intra- and epidural
Zingg *et al.* [47]	23 (23)	0% (0–14.82) 0% (0–14.82)	Clinical outcome study	N/R	General
Total	**Hip cases: 4577**	**DVT** 1.18%; 95%CI [0.8–1.74] **PE** 0.59%; 95%CI 0.38–0.92].			

prospective follow-up studies. Although trim and fill method is a reliable tool to address publication bias, we cannot assume that the last was eliminated. Another limitation of this study is the selection of hip cases that were analysed. We focused on patients that had no previous surgery and no history or pre-operative diagnosis of pigmented villonodular synovitis, avascular necrosis of the femoral head, acute traumatic FAI, SCFE and LCPD. We excluded studies that did not provide any information about the patient history of disease or previous hip procedures, but this does not completely eradicate the risk of including cases that were not eligible. Thus, the homogeneity of the study population may be questionable. The highest proportion of VTE after hip arthroscopy was detected in two prospective studies where ultrasound was used to screen both symptomatic and asymptomatic patients at pre-determined time points after the procedure. Fukushima *et al.* [12] reported 6.94% incidence of DVT in a cohort of 72 patients. Mohtadi *et al.* [13] also used Doppler ultrasound to screen patients for DVT on days 10–22 after hip arthroscopy and reported an incidence of 4.3% (4 cases). Ultrasound screening for the development VTE after orthopaedic procedures is not currently recommended in asymptomatic individuals. On the other hand, asymptomatic cases might have remained undetected and were not included in this analysis, leading to possible underestimation of the proportion of VTE.

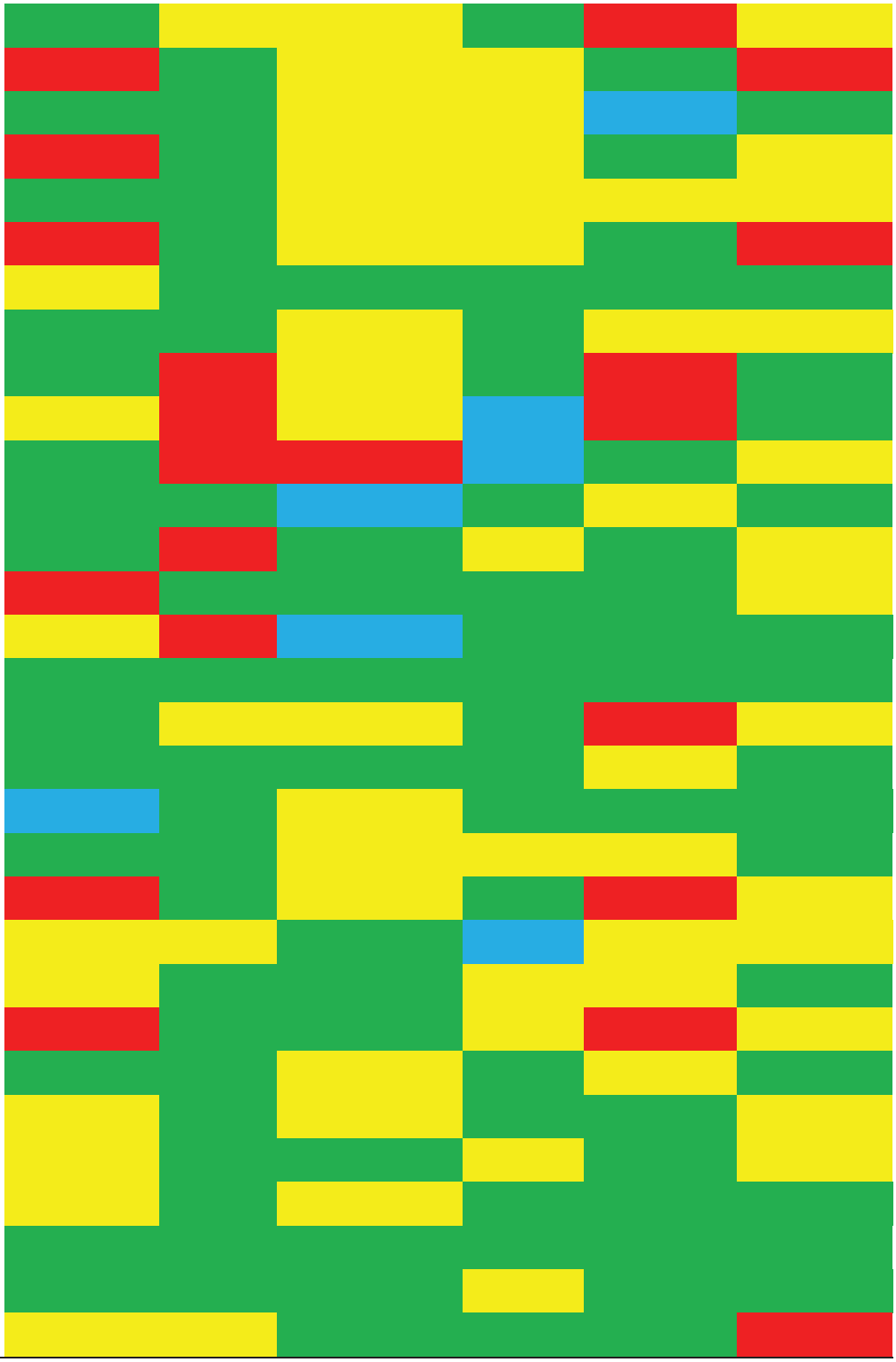
Background and rationale

The systematic review found the rate of DVT and PE in patients undergoing primary hip arthroscopy for FAI to be 1.18% and 0.59%, respectively. Publication bias was evident when calculating the DVT rate which was raised to 2.02% after the bias was corrected. In addition, significant amount of confounding and attrition bias was detected among the studies. Thus, current evidence is insufficient to introduce specific recommendations regarding the administration of routine anti-VTE chemoprophylaxis in low-risk patients undergoing primary hip arthroscopy for FAI.

Recently, Haldane *et al.* [14] compared the post-hip arthroscopy VTE rate (PE and DVT events) in patients who underwent hip arthroscopy for FAI and were administered VTE chemoprophylaxis versus those who did not. The VTE rate was 2% in patients where VTE prophylaxis was used and 2.3% in the group of patients who did not take VTE chemoprophylaxis. Due to key differences in

Table II. Types and distribution of bias among the studies

Author	*Participation*	*Attrition*	*Prognostic factor*	*Outcome*	*Confounding*	*Statistics eeporting*
Alaia *et al.* [21]						
Awan *et al.* [22]						
Byrd *et al.* [23]						
Byrd *et al.* [9]						
Byrd *et al.* [25]						
Byrd *et al.* [24]						
Byrd *et al.* [27]						
Byrd *et al.* [26]						
Chan *et al.* [19]						
Collins *et al.* [20]						
Contreras *et al.* [28]						
Dietrich *et al.* [10]						
Dutton *et al.* [11]						
Domb *et al.* [29]						
Flecher *et al.* [30]						
Fukui *et al.* [31]						
Fukushima *et al.* [12]						
Gupta *et al.* [16]						
Hartigan *et al.* [32]						
Haviv *et al.* [33]						
Horisberger *et al.* [34]						
Javed *et al.* [35]						
Kamath *et al.* [36]						
Krych *et al.* [37]						
Larson *et al.* [38]						
Lo *et al.* [39]						
Mei Dan *et al.* [41]						
Matsuda *et al.* [40]						
Mohtadi *et al.* [13]						
Nossa *et al.* [42]						
Pailhe *et al.* [43]						



(continued)

Table II. (continued)

Author	*Participation*	*Attrition*	*Prognostic factor*	*Outcome*	*Confounding*	*Statistics eeporting*
Park *et al.* [44]						
Polat *et al.* [45]						
Roos *et al.* [46]						
Salvo *et al.* [18]						
Seijas *et al.* [1]						
Souza *et al.* [2]						
Zingg *et al.* [47]						

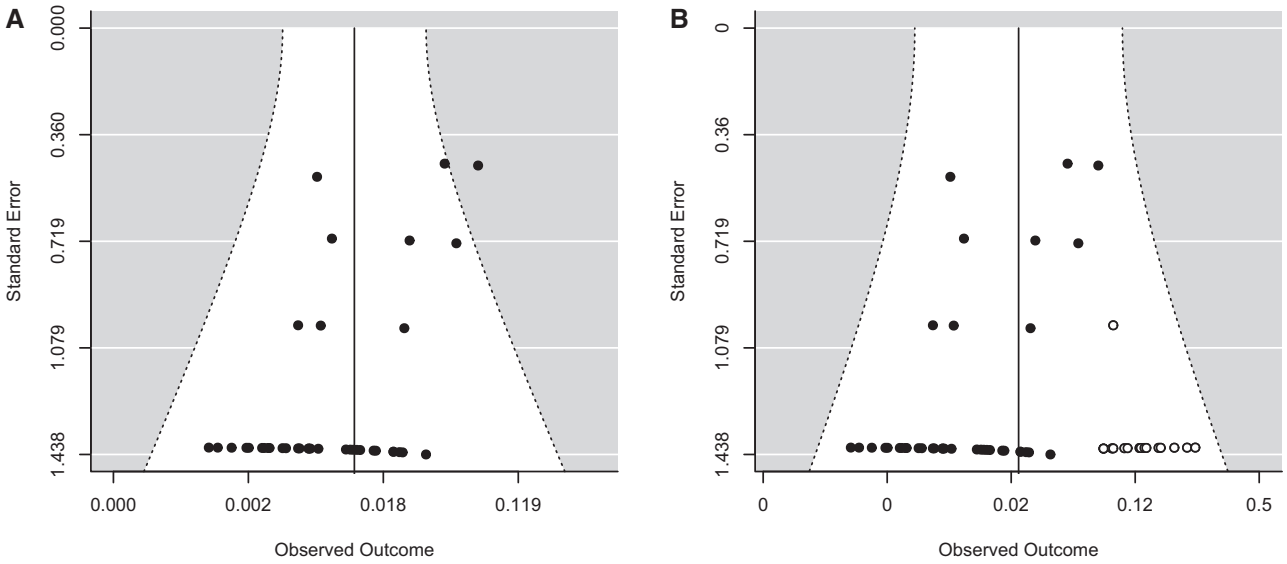


Fig. 2. Funnel plots indicating meta-analysed estimate for DVT rate (**A**) using a random-effects model for the included studies, and (**B**) utilizing the trim-and-fill method as a sensitivity analysis. Black dots represent actual studies included in this systematic review, and asymmetry of these dots indicate possible publication bias. White dots represent hypothetical study observations created and used by the trim-and-fill method.

study design and extraction of the results, comparisons with our systematic review are difficult to make. Our patient population included low risk patients who underwent primary hip arthroscopy for FAI but the selection process to identify the hip cases eligible for analysis was conducted in two stages; first, we applied the study selection criteria to identify eligible articles. At a second stage, we applied inclusion and exclusion criteria to the hip cases included in the study population of each of the selected studies. The last was to ensure that selected patients did not have known risk factors to develop VTE following hip arthroscopy and underwent primary hip arthroscopy for FAI without additional procedures (see Meta-analysis section). We excluded articles where the indications for hip arthroscopy were not clearly stated because this could increase the probability of population heterogeneity. For example, in a study by Clarke *et al.* [15], which was included in the systematic review of Haldane *et al.* [14], the study population included patients who underwent hip arthroscopy for undiagnosed hip pain (41%) and other miscellaneous conditions (13%). The last could serve as significant confounder. In addition, we reported the DVT and PE rates separately whereas Haldane *et al.* [14] reported an overall VTE rate of approximately 2% which included 22 DVT events and 3 PE events. We identified 23 cases of DVT and 2 cases of PE in patients who suffered VTE after

surgery. If any patient was at higher risk for VTE based on the medical history and/or underwent concomitant procedures to address pathology other than FAI, he or she was excluded from our analysis. Similar to our study, the authors included symptomatic and asymptomatic cases of VTE. Kowalczuk *et al.* [4] reported an overall complication rate of 4% in patients undergoing hip arthroscopy with 0.3% of those being major complications including DVT. DVT was reported as the second most common (4/20, 0.2%) after intra-abdominal fluid extravasation. Harris *et al.* [3] reported a major complication rate of 0.58% in a meta-analysis of 6334 hip arthroscopy cases including seven cases of DVT (0.1%). The proportion of VTE was underestimated in both studies [3, 4]. The last could be explained by the fact the numerous other complications were reported concomitantly [3, 4].

Mohtadi *et al.* [13] detected one case of asymptomatic DVT by ultrasound screening of a group of low-risk patients who underwent hip arthroscopy in a prospective study. Fukushima *et al.* [12] detected five asymptomatic cases of DVT (confirmed by ultrasound) in a group of 72 patients who underwent hip arthroscopy for FAI syndrome. Although routine ultrasound for DVT is not recommended for asymptomatic patients following orthopaedic procedures, these findings raise concerns in whether hip arthroscopy, as a procedure itself, carries increased risk of development of DVT relative to knee arthroscopy where no VTE chemoprophylaxis is recommended by the ACCP in low-risk individuals [6]. Because hip arthroscopy is relatively new procedure and the above findings may be of important clinical significance, the asymptomatic cases of DVT/PE were included in our analysis.

The proportion of DVT patients undergoing primary hip arthroscopy for FAI syndrome was 0.59% in this study. We identified only two cases of DVT in a study population of 4577 patients. The first case of PE was a 30-year old female without pre-existing risk factors for VTE who received general anaesthesia and traction was applied for 50 min during surgery. The patient did not receive chemoprophylaxis for VTE after surgery and she was on toe-touch weight bearing restriction. She developed tachypnea 12 days postoperatively. Imaging studies revealed acute pulmonary emboli in the segmental branches of left upper and lower lungs. Lower extremity ultrasound was negative for DVT. This shows that symptomatic DVT does not necessarily precede the occurrence of PE and the patient can present solely with pulmonary symptoms. The other case of PE was an obese patient with BMI between 35 and 39 who also developed acute DVT in different study [16]. Whether this last patient received chemoprophylaxis against VTE was not reported. In addition, it is unclear if obesity serves as an independent risk factor for the development of VTE after surgery. [17] As mentioned in the previous paragraph, Mohtadi *et al.* [13] as well as Fukushima *et al.* [12] detected six cases of asymptomatic DVT by ultrasound screening of a group of low-risk patients who underwent hip arthroscopy. Both studies were prospective. These asymptomatic events of DVT could have potentially resulted in PE and patient death. Based on that, whether routine chemoprophylaxis against VTE should be administered in patients undergoing hip arthroscopy for FAI is a subject that surgeons must take into serious consideration. Harris *et al.* [3] detected two cases of PE and Haldane *et al.* [14] detected three cases of PE in their study.

Implication in clinical practice

Previous systematic reviews characterize the incidence of VTE after hip arthroscopy, with the highest reported percentage being 2.3%, as low. [3, 4, 14] We calculated the DVT rate following primary hip arthroscopy for FAI in low risk patients as 1.18% (which was raised to 2.2% after the correction of publication bias) and the PE rate as 0.59%. The study population in the above cohorts, including ours, consists of young patients (mean age less than 45 years) who underwent an elective procedure. Given the life-threatening character of VTE complication an incidence rate of 1–2% cannot be neglected in clinical practice. No data exists to support that DVT chemoprophylaxis should be administered in low-risk patients who undergo hip arthroscopy for FAI, however; the existing evidence is of low quality and this might result in underestimation of a serious clinical problem. The last was clearly stated in the systematic review of Haldane *et al.* [14] a finding that our study confirms.

Implication in research

There is need to design higher quality studies that will lead to the establishment of evidence-based guidelines for the administration of VTE chemoprophylaxis in low risk patients who undergo hip arthroscopy for FAI; follow-up studies should consistently report the rate and type of post-operative complications observed, including VTE events. Also, whether anti-VTE measures were taken following the procedure as well as the type of these preventive measures should be reported. Clinical trials will help decide if routine VTE prophylaxis should be implemented in clinical practice, and the efficacy of various VTE prophylactic measures should be assessed.

CONCLUSION

Insufficient evidence exists to support whether anti-VTE chemoprophylaxis should be administered to patients undergoing primary hip arthroscopy for FAI. Level IV studies composed most of meta-analysed articles and publication bias significantly affected the results. Due to the life-threatening character of this complication, these results should serve as starting point to design clinical trials and establish guidelines. Until then, the application of prevention measures against VTE should be decided on a case-by-case basis to ensure patient safety.

CONFLICT OF INTEREST STATEMENT

None declared.

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