

Incidence of deep venous thrombosis following periacetabular and derotational femoral osteotomy: a case for mechanical prophylaxis

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ABSTRACT

There are currently no established guidelines for appropriate antithrombotic prophylaxis following periacetabular osteotomy (PAO) or derotational femoral osteotomy (DFO). The purpose of this study was to determine the incidence of clinical deep venous thrombosis (DVT) following PAO and/or DFO wherein a portable, mechanical device and low-dose aspirin were used postoperatively for DVT prophylaxis. Patients who had undergone staged hip arthroscopy and primary PAO and/or DFO were prospectively reviewed. Following PAO/DFO, patients were prophylactically treated for thromboembolic disease with a portable, mechanical compression device for 3 weeks and low-dose aspirin for 4 weeks. Patients were followed in clinic until 24 months postoperatively. During the study period, 145 hips (124 patients) underwent surgery (PAO: 109, DFO: 24, PAO + DFO: 12). Overall, the incidence of clinically apparent DVT was 0% in the study cohort. Average estimated blood loss during surgery was 601 mL and five cases required blood transfusions of 1 or 2 units. Ten patients were seen in the emergency room 10–20 days after surgery presenting with calf tenderness and DVT was ruled out in all cases with ultrasound. There were no postoperative bleeding or wound complications. A portable, mechanical compression device and low-dose aspirin effectively lessens the risk of DVT following staged hip arthroscopy and PAO/DFO without an increased risk of bleeding complications.

INTRODUCTION

Periacetabular osteotomies (PAO) to address hip dysplasia are increasingly performed and little information is available in the literature regarding appropriate antithrombotic prophylaxis for these complex procedures. The incidence of thromboembolic complications following PAO alone is between 0% and 2.1% based on prior reports [1–6]. However, this incidence increases to approximately 5% when PAO is combined with a proximal femoral osteotomy [7]. A derotational femoral osteotomy (DFO) is indicated to correct femoral torsion in cases of femoroacetabular impingement (FAI) and/or hip dysplasia associated with excessive femoral ante- or retroversion [8]. To date,

no study has sought to determine the risk of thromboembolic disease following DFO alone.

A high incidence of intra-articular pathology has been reported in patients with hip dysplasia in various studies [9, 10] and hip arthroscopy has been recommended prior to a PAO to address labral and cartilage pathology and femoral head-neck offset abnormalities in patients with concomitant FAI. Routine thromboprophylaxis is not indicated following hip arthroscopy except in high-risk patients, as the risk of deep venous thrombosis (DVT) or pulmonary embolism (PE) following this procedure is around 0.1% [11, 12]. However, when hip arthroscopy is performed concomitantly with a PAO, small case series

have reported a substantially higher risk of postoperative venous thromboembolism (VTE) for the combined procedure, from 2.3% to 5.9% [13, 14]. Hip arthroscopy may be performed either concomitantly with a pelvic osteotomy or in a staged manner and, in either case, can potentially increase the risk of thromboembolism and warrant thromboprophylaxis.

Chemical antithrombotic prophylaxis is associated with a higher cost, issues with patient compliance, bleeding-related complications and other medication side effects [15–17]. However, mechanical prophylaxis requires patient compliance and appropriate application in order to be effective [18, 19]. Recent studies have demonstrated that portable compression devices (PCDs) have improved compliance and reduce the risk of postoperative DVT compared to non-mobile devices [20–22]. Furthermore, mobile compression devices have been shown to significantly reduce the risk of bleeding events following total hip or knee arthroplasty, with a symptomatic DVT rate that is equivalent to that of chemical antithrombotic agents such as low-molecular-weight heparin [23, 24]. The purpose of this study was to determine the incidence of clinical DVT following staged hip arthroscopy and PAO and/or DFO at our institution using a portable, mechanical compression device and low-dose aspirin postoperatively.

MATERIALS AND METHODS

After Institutional Review Board approval was obtained, the authors performed a single-center prospective study on a cohort of patients who had undergone staged hip arthroscopy and primary PAO and/or DFO. Inclusion criteria for patients undergoing these procedures were as follows: (1) persistent hip pain and mechanical symptoms refractory to non-operative management (physical therapy, non-steroidal anti-inflammatory drugs, activity modifications, corticosteroid injections) lasting at least 3 months, (2) reproducible clinical examination findings suggestive of intra-articular pathology and (3) joint-space width exceeding 3 mm on all views of plain radiography and cross-sectional imaging. Some of the physical examination tests used included passive hip range of motion (supine, lateral, prone), the FADIR (flexion, adduction, internal rotation) test, the FABER (flexion, abduction, external rotation) test, the ligamentum teres (LT) test, the posterior impingement test, use of the Beighton Hypermobility score and subjective reports of hip instability [25]. The lateral center edge angle (LCEA) was determined on anteroposterior (AP) pelvis radiographs as described previously [26]. Patients with a LCEA between 20 and 24.9° were diagnosed with borderline hip dysplasia and those with values < 20° were diagnosed with frank hip dysplasia. Other

parameters included in the decision-making process were: hyperlaxity, anterior under-coverage and acetabular ante/retro version and excessive femoral anteversion (> 37°) or retroversion (< -7°).

Common indications for hip arthroscopy were cam-type FAI, cartilage damage/subchondral cyst and labral tears (prior to PAO) and/or excessive femoral torsion (prior to DFO) with or without FAI. Some patients with excessive femoral ante/retroversion or borderline hip dysplasia had failed an arthroscopic-only approach used as first-line treatment and required a bony realignment procedure.

Demographic variables including age, clinical diagnosis, gender, height, weight and body mass index (BMI) were recorded for all patients.

Imaging protocol and measurements

After a comprehensive clinical evaluation by the senior author, patients underwent a standardized series of AP pelvis radiographs, MRI dGEMRIC and whole-pelvis computed tomography (CT) scans with 3D reconstructions. Standard AP pelvis films were obtained with the patient positioned supine or upright with the lower extremities internally rotated 15° to maximize femoral neck length. The X-ray beam was directed midway between the anterior superior iliac spine (ASIS) and the pubic symphysis, with a focus film distance of 120 cm [27]. Radiographs were determined to be adequate given symmetric obturator foramina and a distance of 1–3 cm between the coccyx and pubic symphysis [28].

Surgical technique

All patients underwent hip arthroscopy without a perineal post [29] prior to PAO/DFO in order to address intra-articular hip pathology such as labral tears, chondral damage, cam lesions and/or LT tendinopathy. The osteotomy procedure was performed 7–14 days following arthroscopy. For cases in which patients underwent all three procedures, hip arthroscopy was performed combined with DFO or 2–5 days prior, while PAO was performed 1 week later. The reason for not performing these procedures together is that the senior author believes that the intra-articular bleeding associated with hip arthroscopy may result in significant scarring and adhesions due to immobility after PAO surgery. Patients use a stationary bicycle intensively between hip arthroscopy and PAO (up to 30 min daily) in an effort to reduce the chances of this happening. Various techniques of periacetabular osteotomy (PAO) [30] and DFO [8] were performed as previously described.

Medication and thromboprophylaxis regimen

For patients undergoing a PAO, tranexamic acid (TXA) was used in 70% of the study's cohort to reduce intraoperative bleeding. Patients are given 1 g of intravenous TXA 30 min prior to the incision and an additional 1 g 3 h later.

If a large cam resection was performed during hip arthroscopy, patients were prophylactically treated to prevent heterotopic ossification with Naprosyn (naproxen) 500 mg twice per day beginning the day following hip arthroscopy until 2 days prior to the scheduled PAO/DFO. Naprosyn was restarted on the day following PAO/DFO and continued for 4 weeks postoperatively.

Immediately following PAO/DFO, patients are placed on a battery-operated, PCD (ActiveCare, Medical Compression Systems, Inc., Or Akiva, Israel) and low-dose (81 mg) aspirin (Fig. 1). PCD is continued for 3 weeks (23 h per day, 7 days per week during first 2 weeks; at night only during the third week) and aspirin for 4 weeks postoperatively.

Postoperative rehabilitation

Patients are encouraged to use a stationary bicycle beginning the day of hip arthroscopy for 3–5 min twice per day,

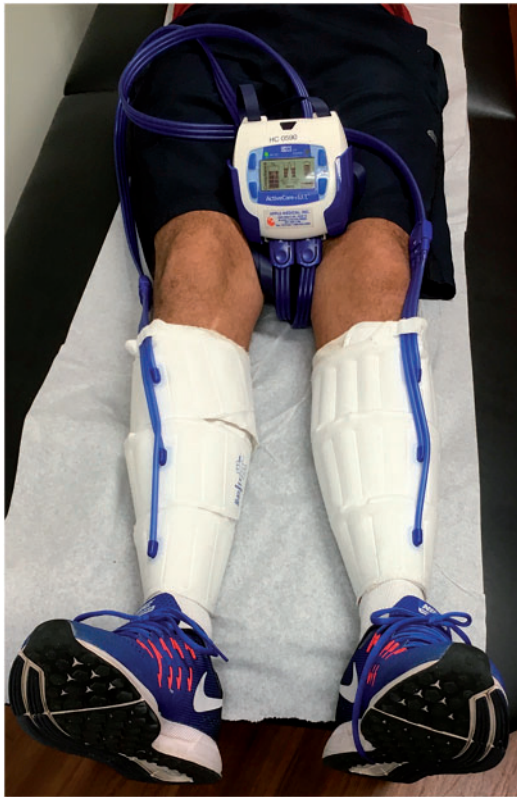


Fig. 1. The PCD (ActiveCare, Medical Compression Systems, Inc., Or Akiva, Israel) worn by all patients in this study.

gradually increasing the duration to 10–15 min of biking twice per day by postoperative day (POD) 7 following hip arthroscopy. Following the osteotomy procedure, patients are either non-weight bearing for 5 weeks if microfracture was performed during hip arthroscopy or partial weight bearing at 50% for 2 weeks followed by weight bearing as tolerated with two crutches thereafter. Patients are discharged from the hospital 2–6 days postoperatively.

Patient education and follow-up

All patients were educated on the signs and symptoms of DVT preoperatively and were provided with handouts with information on DVT based on the published literature [31]. All patients were evaluated while inpatients and in the clinic at 2 weeks, 6 weeks, 3 months, 6 months, 1 year and 2 years following the osteotomy procedure.

RESULTS

During the study period, 145 hips (124 patients) underwent surgery (PAO: 109, DFO: 24, PAO + DFO: 12). Average age at the time of surgery was 30.1 years (range, 15–50 years) and average BMI was 23.8 kg/m² (range, 16.3–44.9 kg/m²). Additional demographic characteristics are summarized in Table I.

Average estimated blood loss during surgery was 601 ml and 5 cases (5/133, 3.8%) required blood transfusions of 1 or 2 units (Table II). Ten patients (10/124, 8.1%) were seen in the emergency room presenting with calf tenderness associated with non-weight bearing status and DVT was ruled out in all cases following Doppler sonography. There were no postoperative bleeding or wound complications in any patients.

Table I. Patient demographics and baseline characteristics

Patient variables	Value
No. of hips (patients)	145 (124)
Age, mean (SD), years	30.1 (8.9)
Female gender, <i>n</i> (%)	118 (95.2)
Height, mean (SD), cm	165.9 (16.6)
Weight, mean (SD), kg	70.0 (20.0)
BMI, mean (SD), kg/m ²	23.8 (5.1)
Current or former smoker, <i>n</i> (%)	29 (23.3)

Table II. Intraoperative characteristics

	No. of cases	Estimated blood loss (mean), ml	Transfusion requirements
PAO	109	668	5 (4.6%)
DFO	24	100	0

PAO, periacetabular osteotomy, DFO, derotational femoral osteotomy.

DISCUSSION

In our study, the incidence of clinically apparent DVT was 0% following PAO and/or DFO using portable mechanical compression devices for 3 weeks postoperatively and low-dose (81 mg) aspirin for 4 weeks postoperatively. This thromboprophylaxis regimen effectively lessens the risk of thromboembolic complications without increasing the risk of postoperative bleeding complications.

The reported incidence of DVT following either isolated hip arthroscopy [11, 12] or pelvic osteotomy [1–6] is low. However, postoperative DVT has been reported in the literature following hip arthroscopy. In a database study using the National Surgical Quality Improvement Program (NSQIP), Cvetanovich *et al.* [11] identified 1338 patients who underwent hip arthroscopy and found only two cases (0.1%) of postoperative DVT. Additionally, in a study of 139 patients who underwent hip arthroscopy without mechanical or chemoprophylaxis, Alaia *et al.* [32] found two cases of VTE (1.4%)—one case of symptomatic DVT and one symptomatic PE.

The risk of DVT following isolated osteotomy procedures about the knee is also low [33], and therefore heparinoids are not commonly used and the related risk in this osteotomy population is unknown. Erickson *et al.* [33] performed a retrospective study of 141 patients (mean age 34 years) who had undergone either a high tibial osteotomy (HTO), distal femoral osteotomy or tibial tubercle osteotomy (TTO) without postoperative chemical thromboprophylaxis. At a mean follow-up of 17.1 months, only two patients (1.4%) developed a below-the-knee DVT, including one patient who had undergone HTO and one who had undergone TTO. This 1.4% is higher than in our cohort (0%), and PAO and DFO are longer surgeries with a higher theoretical risk for DVT compared with HTO/TTO. Tanaka *et al.* [34] found a DVT rate of 3.8% (6/156) in a retrospective chart review of patients who had undergone TTO. Postoperative anticoagulation was used in 45 cases (28.8%), though the authors did not comment on any heparinoid-related complications in this cohort.

In patients undergoing combined hip arthroscopy and pelvic osteotomy, thromboembolic risk may increase [13, 14]. In a retrospective case series of 17 patients who had

undergone concomitant hip arthroscopy and PAO, Domb *et al.* [13] found one case of PE (1/17, 5.9%) in a patient who had refused to discontinue an oral contraceptive. Kim *et al.* [14] prospectively evaluated 43 hips undergoing concomitant hip arthroscopy and PAO, with one patient (1/43, 2.3%) developing a DVT postoperatively. At our institution, hip arthroscopy and osteotomy procedures were performed in a staged fashion within 1–2 weeks and showed no cases of DVT. No prior studies have sought to determine the risk of thromboembolic disease following staged hip arthroscopy and PAO/DFO.

Chemical thromboprophylaxis with enoxaparin or rivaroxaban following joint arthroplasty has been associated with major postoperative complications such as bleeding and infection [16, 17, 35] which, aside from the clinical and subjective discomfort and delay in rehabilitation progression, sometimes requires taking the patient back to the operating room to address the developing hematoma and bleeding. These complications must be taken into account when selecting an appropriate thromboprophylaxis regimen following complex orthopedic procedures. Mechanical prophylaxis in the form of intermittent pneumatic compression devices do not interfere with blood homeostasis and recent reports in patients undergoing hip or knee arthroplasty have demonstrated that mechanical prophylaxis using portable devices is as effective as chemical prophylaxis without the associated bleeding- or wound-related complications [23, 24]. However, mechanical devices require patient compliance in order to be effective.

With the use of portable, mechanical compression devices, patient compliance can be improved [20–22]. Because these devices are small and portable, patients can wear them during daily activities or at work during the early postoperative period. These devices have been used successfully following total hip arthroplasty and the American College of Chest Physicians has recommended the use of portable, battery-powered mechanical compression devices without concomitant chemical prophylaxis following total hip or knee arthroplasty or hip fracture surgery [36]. Antithrombotic prophylaxis is recommended for a minimum of 10–14 days following these procedures [36]. In our study, no patients presented with clinical signs of DVT using these PCDs and low-dose aspirin following PAO and/or DFO.

TXA has been used in prior studies to reduce bleeding and transfusion requirements for patients undergoing PAO [37, 38]. These studies demonstrated a reduction in estimated blood loss and transfusion requirements during this procedure. Similar to these studies, the authors also use

TXA pre- and intraoperatively and we did not observe any cases of thromboembolic complications in our series.

To reduce the risk of heterotopic ossification, the authors routinely use naproxen following hip arthroscopy if a cam lesion was resected. There has been some concern within the cardiology literature regarding a potential interaction between naproxen and low-dose aspirin [39], though a recent study [40] has shown that naproxen does not affect the platelet inhibitory effect of aspirin. Moreover, aspirin inhibits the platelet function using a different mechanism than thromboxane [41] and naproxen itself has a platelet inhibitory effect similar to that of aspirin [42]. In our study, no issues were observed with the concomitant usage of naproxen and aspirin.

The strengths of this study include the prospective evaluation of a large sample size of patients undergoing staged hip arthroscopy and PAO and/or DFO. The limitations of this study should also be noted. In particular, patients were not screened for postoperative DVT with the use of Doppler ultrasound or venography. However, all patients were educated on and were provided with handouts on the signs and symptoms of DVT. As another limitation of this study, the usage time of the portable, mechanical compression devices was recorded by patients' subjective reports rather than in an objective manner. Finally, patients were also instructed to take low-dose (81 mg) aspirin postoperatively, and therefore it is not possible to determine if the lack of deep venous thromboses presenting in this cohort is attributed more to the use of PCDs or low-dose aspirin.

An antithrombotic prophylaxis regimen consisting of portable, mechanical compression devices and low-dose aspirin effectively lessens the risk of clinically apparent DVT following staged hip arthroscopy and PAO/DFO without an increased risk of postoperative bleeding complications.

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CONFLICT OF INTEREST STATEMENT

None declared.

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