Thromboembolism Following Foot and Ankle Surgery: A Case Series and Literature Review

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Venous thromboembolism following major orthopedic procedures of the hip and knee is well documented and patients are therefore routinely prophylaxed following these proximal lower extremity procedures. In contrast, foot and ankle surgery is considered by most health care professionals to be a low-risk procedure for the development of venous thromboembolism. As a result, pharmacologic deep venous thrombosis prophylaxis is rarely administered. This postoperative practice is supported by the literature regarding deep venous thrombosis following foot and ankle surgery. In this article, we review the risk factors and explore the occurrence of thromboembolism after foot and ankle surgery in the literature. We also present our restrospective study of patients who developed venous thromboembolism after forefoot, midfoot, hindfoot, and ankle procedures. Over the course of 1.5 years, 4 of a consecutive series of 1000 patients (0.4%) developed a deep venous thrombolism and 3 of 1000 (0.3%) developed nonfatal pulmonary emboli. In our series, each of our patients who developed venous thromboembolism had at least 2 identifiable risk factors. The incidence of venous thromboembolism following foot and ankle surgery is rare (less than 1%), and the need for routine propylaxis postoperatively is not supported by any high level of evidence studies. Level of Clinical Evidence: 4 (The Journal of Foot & Ankle Surgery 47(3): 243–249, 2008)

Key Words: deep venous thrombosis, pulmonary embolism, venous thromboembolism, prophylaxis

Thromboembolic disease following major orthopedic surgery of the hip and knee is well recognized and some form of routine antithrombotic prophylaxis is the standard of care following these procedures (1). In contrast, prophylaxis following foot and ankle surgery is not standardized as the incidence of thromboembolism following these surgeries is reported to be rare. The purpose of this study was to describe the characteristics of a series of patients who sustained a thromboembolic event following foot and ankle surgery at our institution, and to review the literature related to venous thromboembolism following foot and ankle surgery.

Patients and Methods

Formal approval of this retrospective study and a waiver of HIPAA authorization to access protected health information was granted by our university's institutional review board before initiation of this study. Patient medical record information over a 1.5-year period, from January 2005 to June 2006, was retrospectively reviewed and evaluated. The inclusion group was a consecutive series of 1000 patients who underwent foot and ankle surgery by one surgeon over a 1.5-year period. None of the patients in this series had experienced multiple trauma. Approximately 85% of the

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TABLE 1 Patient information and VTE risk assesment

Patient	Age	Gender	BMI	Procedure	Tourniquet Site & Time	Anesthesia
1	40	F	47.7	Dorsal partial talar exostectomy	Calf, 21 min	General
2	56	F	35.6	Removal of external fixator (Application of fixator with midfoot osteotomy and pTAL 139 days prior)	Not used	General for 1st surgery, spinal for 2nd
3	26	M	30.9	ORIF ankle fracture	Calf, 60 min	General
4	68	F	29.8	Modified McBride bunionectomy, arthrodesis of 1st, 2nd & 3rd TMT joints, and harvesting of calcaneal autograft	Calf, 90 min	General
5	49	M	36.7	Cheilectomy of 1st metatarsal head	Calf, 30 min	General
6	46	F	26.1	Arthrodesis of 1st, 2nd, & 3rd TMT and intercuneiform joints with harvesting of distal tibial autograft	Ankle, 75 min	General
7	52	F	33.7	Medial calcaneal displacement osteotomy, FDL transfer & pTAL	Calf, 75 min	General

Abbreviations: DVT, deep venous thrombosis; PE, pulmonary embolism; BMI, body mass index; WB, weight bearing; NWB, non-weight bearing; WBAT, weight bearing as tolerated; IBS, inflammatory bowel disease; pTAL, percutaneus tendo-Achilles lengthening; HTN, hypertension; DM, diabetes mellitus; CA, cancer; ORIF, open reduction and internal fixation; TMT, tarsometatarsal; FDL, flexor digitorum longus; SC, subcutaneus.

surgical procedures were elective, and 15% were semi-elective or urgent (infections or fractures requiring surgery). Less than 10% of the patients treated during this time period were immobilized preoperatively or had a period of bedrest before the actual procedure. This group of patients included fractures that were immobilized before definitive surgery, patients with infections who were admitted to the hospital, or patients with fractures who were admitted for pain control or control of swelling. During this time period, 1000 consecutive patients underwent foot and/or ankle surgery by the principal investigator. Routine screening for postoperative venous thromboembolism (VTE) was not performed and only those patients who presented with symptoms were further evaluated. Our method of studying only symptomatic patients is consistent with other reported studies (2–5). Patients who complained of calf or popliteal pain, unusual swelling, or had calf tenderness were sent for Doppler venous studies. Patients who complained of shortness of breath and/or pleuritic chest pain were evaluated with spiral computerized tomography (CT) of the chest.

Results

The principal investigator (D.W.) performed foot and ankle surgery on 1000 consecutive patients over the course of 1.5 years. Descriptive results for the case series are depicted in Table 1. No patients undergoing outpatient surgery received prophylaxis against VTE. All patients undergoing surgery that required admission to the hospital received low molecular weight heparin (Lovenox 40 mg) subcutaneously beginning on the morning following surgery. They remained on this during their hospital stay. Major procedures requiring admission included open treatment of fractures, major arthrodeses (ankle, hindfoot and midfoot), and osteotomies of the ankle, hindfoot and midfoot. None of the patients received low molecular weight heparin on the day prior to or day of surgery due to concerns of perioperative bleeding. Our choice to continue low molecular weight heparin following discharge in only 10% of patients was based on the lack of scientific evidence supporting the need for antithrombotic medication in patients who undergo foot and ankle surgery. The 10% who received prophylaxis after discharge had multiple risk factors and we chose to administer low molecular weight heparin for 14 days. We acknowledge that the methodology by which we based our decision to prescribe post-discharge anticoagulation and for how long was not standardized. No patient in this series developed a postoperative complication from the administration of anticoagulation such as hematoma formation. The incidence of symptomatic DVT of the lower extremity was 0.4% (4 out of 1000) and that of pulmonary embolism was 0.3% (3 out of 1000). As can be seen from these numbers, the 3 patients with pulmonary embolism did not demonstrate deep venous thrombosis in the lower ex-

TABLE 1 continued

DVT Prophylaxis	Immobilization	Postoperative WB Status	DVT or PE Complication	Days Following Surgery when DVT/PE was Diagnosed	Risk Factors
No	Jones compression splint	NWB for 8 days	DVT	14	Age, obese, NWB >1 week, IBS
14 days of enoxaparin 40 mg SC was given for initial surgery but not after 2nd surgery	Jones compression splint after fixator removal	NWB for a total of 159 days from initial surgery	DVT	147 days after initial surgery & 8 days after 2nd surgery	Age, obese, NWB >1 week, HTN varicosities, DM, uterine & breast CA, PE
No	Jones compression splint	NWB for 56 days	DVT	7	NWB >1 week, obese
14 days of enoxaparin 40 mg SC	Jones compression splint for 1st 22 days, then cast for 11 days	NWB for 42 days	DVT	33	Age, NWB >1 week, HTN
No	No	WBAT	PE (nonfatal)	3	Age, obese, NWB >1 week, hyperlipidemia
No	Jones compression splint for 1st 27 days, then cast for 28 days	NWB for 55 days	PE (nonfatal)	<1	Age, HTN, NWB >1 week
No	Jones compression splint for 5 days, than cast for 43 days	NWB for 48 days	PE (nonfatal)	45	Age, obese, NWB >1 week, IBS, HTN, FH

tremity using duplex ultrasonography. The most likely explanation is that a thrombus dislodged from intrapelvic vessels resulting in PE. One of the limitations of duplex ultrasound is this failure to visualize intra-pelvic thrombi. Deep venous thrombosis was confirmed with Doppler venous studies and PE was diagnosed with spiral CT. The total incidence of venous thromboembolism (VTE) was 0.7% (7 of 1000). Three females and 1 male developed a DVT and 2 females and 1 male developed a PE. The procedures included forefoot, midfoot, hindfoot, and ankle operations. Nine hundred (90%) of the 1000 patients had a calf or more distal tourniquet applied and 100 (10%) of the 1000 patients had a thigh tourniquet placed. Although a tourniquet was applied in all patients, 30 (3%) of the 1000 patients did not have the tourniquet inflated. The total tourniquet time never exceeded 130 minutes except in 1 patient who did not develop VTE. Five (71%) of the 7 patients who developed a postoperative VTE had a calf tourniquet, with inflation time ranging from 21 to 90 minutes. One patient had an ankle tourniquet inflated for 75 minutes and 1 patient did not require the use of a tourniquet. Regional anesthesia, such as popliteal and saphenous nerve blocks, was used for 75% of the procedures, although spinal and general anesthesia was employed at the discretion of the anesthesia attending. One patient who underwent open reduction and internal fixation of an ankle fracture was immobilized preoperatively for 4 days in a Jones dressing with splint. One other patient had been stabilized with a circular external fixator for 139 days.

Two of the 7 patients who developed VTE were administered DVT prophylaxis for 14 days with a daily dose of 40 mg of enoxaparin initiated the morning after surgery. The first of these 2 patients (patient 2) was a 56-year-old obese diabetic female who underwent a 2-stage Charcot reconstruction. She received prophylaxis after her initial surgery, which consisted of a left midfoot osteotomy with application of a multi-planar external fixator and a percutaneous tendo-Achilles lengthening to correct a severe Charcot rocker bottom deformity. Subsequently, a DVT developed 8 days after her external fixator was removed, which was 147 days after the initial surgery. After removal of the external fixator the patient was placed in a total contact cast and advised to be partial weight bearing. She did not receive DVT prophylaxis after her external fixator removal. The other patient was a 68-year-old female (patient 4) who underwent a left foot bunionectomy and midfoot arthrodesis with harvesting of a calcaneal autograft, was prophylaxed immediately postoperatively for DVT. This patient was hospitalized 21 days postoperatively for acute acetaminophen induced hepatitis. During her 3-day hospitalization she did not receive prophylaxis, and her DVT developed subsequent to this on postoperative day 33.

Five of the 7 patients developed a VTE within 2 weeks of their last surgery. Patient 4 developed a DVT 33 days after

her surgery despite 14 days of DVT prophylaxis and patient 7 developed a PE 45 days following medial displacement osteotomy of the calcaneus, FDL transfer and lengthening of the Achilles tendon for stage 2 adult acquired flatfoot deformity. This patient's postoperative course was complicated by *Clostridium difficile* colitis that required admission to the medical service 35 days after surgery. During this 3-day hospitalization the patient was essentially at bed rest and did not receive VTE prophylaxis. After this patient's surgery, her medical consultant elected to place her on aspirin 325 mg per day as a form of prophylaxis. The surgical team was unaware of the second admission for gastroenteritis. We do not know why anticoagulation was not prescribed during the additional period of hospitalization and immobility.

Non–weight bearing for more than 1 week was the only risk factor common to all 7 patients, however 6 of the 7 patients were obese (body mass index $\geq$ 30) and the other was overweight (body mass index = 25.0–29.9). Body mass index was defined as weight in kilograms divided by the patient's height in meters squared. Age older than 40 and immobilization in a Jones compression splint or short leg cast were risk factors associated with 6 of 7 patients. All 7 of the patients who developed VTE in our series had at least 2 identifiable risks factors such as age older than 40, non–weight bearing for at least 1 week, obesity, or concomitant illness.

Discussion

Risk Factors

Numerous risk factors of surgery, especially orthopedic procedures, have been linked to increased rates of thromboembolism. Inherited or acquired hypercoagulable states are reported to exist in 20% to 30% of DVT cases (6, 7). The most common of the inherited hypercoagulable states is Factor V Leiden, a mutated form of coagulation factor V (2, 3, 6, 8). Factor V Leiden causes resistance to protein C antithrombotic activity (2, 3, 6, 8). Prothrombin G20210A mutation, anticardiolipin antibody syndrome, lupus anticoagulant, and mild hyperhomocysteinemia are additional molecular disorders associated with VTE (2, 6, 8). Heritable deficiencies of the endogenous anticoagulants protein C, protein S, and antithrombin III are additional hypercoagulable states contributing to thrombosis (2, 3, 6, 8).

Other general or acquired factors have been associated with an increased prevalence of thrombosis. These include age older than 40 years, sepsis, prolonged hospital stay, air travel, congestive heart or respiratory failure, nephrotic syndrome, obesity, varicosities, oral contraceptives, estrogen therapy, spinal cord injury, stroke, inflammatory bowel disease, cigarette smoking, pregnancy, surgery requiring over 30 minutes of anesthesia, femoral venous catheter, diabetes, hypertension, and hyperlipidemia (2, 3, 8–10). Highly associated risk factors include a history of thromboembolism, malignancy, and a personal or family history of symptomatic thrombi formation without known etiology (2, 3, 8).

Edmonds et al (11) conducted a systematic review of over 250 articles to determine the evidence base behind suggested risk factors of postoperative DVT. They found good evidence to corroborate a significant relationship between a higher prevalence of postoperative thrombosis with increased age, obesity and previous history of thromboembolism, varicose veins, oral contraceptive pills, malignancy, Factor V Leiden gene mutation, general anesthesia, and orthopedic surgery (11). In this study, no evidence was found to support the association of increased risk of DVT with pregnancy, hormone replacement therapy, gender, ethnicity or race, chemotherapy, other thrombophilias, cardiovascular factors, blood type, or smoking (11).

Risk factors of thromboembolism after foot and ankle surgery include tourniquet time more than 90 minutes, operating room time more than 105 minutes, and time to surgery more than 27 hours following ankle trauma (2, 3). The sedentary postoperative period of immobility via splintage, casting, and weight-bearing limitations are further factors potentially contributing to thromboembolism following distal lower extremity procedures (2, 8, 10). Mizel et al (4) reported the only predisposing factors associated with an increased incidence of VTE after foot and ankle surgery in their study were postoperative non–weight bearing and immobilization. In another study regarding VTE after foot and ankle surgery, Solis and Saxby (12) found the risk factors of DVT were postoperative immobilization, hindfoot surgery, increased tourniquet time, and advancing age.

In a prospective, randomized study of 117 lower extremities of 71 patients following forefoot surgery, Simon et al (13) found no cases of thrombosis formation based on I-labeled fibrinogen, Doppler ultrasound, and phleborheography. The patients were grouped according to no tourniquet use, Esmarch bandage exsanguination before tourniquet inflation, and limb elevation exsanguination prior to tourniquet application (13). The authors concluded that the use of a thigh tourniquet did not increase VTE risk after forefoot surgery, including elective bunionectomy, metatarsal osteotomy, resection arthroplasty, or a soft-tissue procedure of the forefoot (13). In contrast, in a prospective, randomized trial of 80 patients who underwent open reduction and internal fixation of simple, closed fractures of the distal fibula, Maffulli et al (14) reported a higher rate of thrombosis in patients operated on with a tourniquet (2 out of 40) than in patients operated on without a tourniquet (0 of 40).

Differentiation between the most prevalent risk factors is crucial (10). Patients with multiple factors are thought to have a higher VTE occurrence as risk factors are additive

(10). Slaybaugh et al (2) formulated a risk assessment scheme with a 4-step protocol to determine the total risk factor value of patients following foot and ankle surgery. The authors established DVT prophylaxis guidelines for inpatients and outpatients based on the calculated total risk factor value from the assessment (2).

Prophylaxis

In September 2004, the American College of Chest Physicians (ACCP) conducted their seventh conference on antithrombotic and thrombolytic therapy (1). Several evidence-based guidelines pertaining to VTE prophylaxis in major orthopedic surgery cases were updated during this meeting. General guidelines support the use of mechanical methods of prophylaxis, such as intermittent pneumatic compression devices, graduated compression stocking, and the venous foot pump, in those at high risk of bleeding or in combination with anticoagulant prophylaxis (1). The ACCP does not advocate the administration of aspirin alone as DVT prophylaxis in any patient population (1). It should be noted that these recommendations were for orthopedic patients undergoing large joint arthroplasty and hip fracture repair. Close attention to the manufacturer's suggested dosing guidelines is encouraged for each of the antithrombotic agents and the ACCP recommends consideration of renal impairment, especially in the elderly and those at high risk of bleeding. Several anticoagulants are primarily excreted by the kidneys and with decreased renal function, these agents can accumulate and cause major bleeding. Also, caution is strongly urged when administering anticoagulant agents following neuraxial blockade such as spinal or epidural anesthesia and continuous epidural analgesia (1). After neuraxial blockage, patients given anticoagulants are at increased risk of developing perispinal hematoma, which can cause spinal cord ischemia and eventual paraplegia (1).

In cases of major orthopedic surgery such as large total joint arthroplasty or hip fracture repair, the ACCP guideline developers concluded the initiation of prophylaxis should be based on the efficacy-to-bleeding tradeoffs for that particular agent (1). Based on evidence finding only small differences between preoperative verses postoperative initiation of low-molecular-weight heparin (LMWH), the ACCP considers both timing protocols acceptable for LMWH, and they determined that routine use of venous ultrasound as a screening tool for VTE at the time of hospital discharge in asymptomatic patients following major orthopedic surgery was unnecessary (1).

Incidence of VTE

The incidence of venous thromboembolism following major orthopedic surgery, such as proximal lower extremity procedures of the hip and knee, is well documented in the literature (1). As such, awareness of the high risk of VTE in this patient population is common knowledge to orthopedic surgeons and as such routine thromboprophylaxis has been employed for over 15 years. In contrast, there have only been a handful of studies evaluating the incidence of venous thromboembolism following distal lower extremity procedures of the foot and ankle. Most studies consider VTE to be a relatively rare complication following foot and ankle surgery and pharmacologic prophylactic agents are not routinely recommended. Recently, orthopedic journals have begun to assign levels of evidence to each published study, and a review of the level of evidence for VTE after foot and ankle surgery is appropriate to this discussion. Level 1 studies are high-quality randomized, prospective studies or a systematic review of several of level 1 studies. Level 2 studies are prospective cohort studies, poorly designed randomized studies, or a systematic review of several level 2 studies. Level 3 studies include retrospective cohort studies with a control group, case control group studies, or a systematic review of level 3 studies. Level 4 studies are case series studies without a historical or control group. Level 5 reports are expert opinion papers, which are usually by invitation and not strictly peer reviewed. While higher-quality studies (ie, levels 1 and 2) should be most helpful in assessing clinical questions, level 3 and 4 studies are also of great value to foot and ankle surgeons (15).

Mizel et al (4) conducted a prospective, multicenter study from January 1995 to December 1995 to evaluate the occurrence of VTE after foot and ankle surgery. Fifteen orthopedic foot and ankle surgeons completed a 1-page questionnaire regarding every foot and ankle surgical procedure conducted within that year. Study parameters included age, height, weight, gender, associated medical conditions, medications, history of thromboembolic disease, type of procedure, tourniquet use and site, and postoperative immobilization and weight-bearing status. The study included 2733 patients who were monitored for clinical signs and symptoms of VTE. The treating physician determined the need for diagnostic testing and prophylaxis in patients suspected of having VTE. Six patients developed clinically detectable DVT (4 in the calf and 2 in the thigh) confirmed by ultrasound or venography. Of those 6 DVT cases, 4 developed nonfatal PE confirmed by ventilation-perfusion scans. Both of the thigh thrombi propagated to become a nonfatal PE. The average onset of symptoms was 34.8 days postoperatively and the range of onset was between 3 to 70 days. The total incidence of thromboembolic events was 6 of 2733 or 0.22% and the incidence of PE was 4 of 2733 or 0.15%. Based on these findings, the authors concluded "routine prophylaxis for thromboembolic disease after foot and ankle surgery probably is not warranted" (level 2 clinical evidence).

In another smaller prospective study of 201 patients,

Solis and Saxby (12) reported the incidence of DVT following foot and ankle surgery. Every patient in this study had duplex ultrasound of the bilateral calves at the first postoperative office visit an average of 10.55 days after surgery. Of the 201 patients, none of whom received prophylaxis, deep calf thrombi were found in 7 patients (3.5% incidence), however none propagated proximal from the calf on follow-up ultrasound, none were clinically symptomatic, and therefore none required treatment. In accordance with Mizel et al (4) and based on their study, the authors did not recommend routine DVT prophylaxis following foot and ankle surgery (level 2 evidence).

Wang et al (3) reported 3 cases of pulmonary embolism following open reduction and internal fixation of ankle fractures. In a case risk assessment, the authors identified several factors contributing to the thrombotic event in each patient. Risk factors were the absence of anticoagulant prophylaxis, immobilization, age older than 40 years, obesity, and PE occurrence within 2 to 4 weeks after surgery. Contrary to the conclusions of Mizel et al (4) and Solis and Saxby (12) the authors "recommend considering the use of anticoagulants for patients with additional risk factors, especially when casts are being used" (level 4 evidence) (3).

Slaybaugh et al (2) also conducted a retrospective review of the incidence of DVT after foot and ankle surgery, in an investigation that included patients who were treated by 8 podiatric foot and ankle surgeons over the course of 1 year. Nine of 1821 patients or 0.5% developed DVT confirmed by venous duplex ultrasound on an average of 31.5 days postoperatively. Nonfatal PE was also found in 3 of the 9 patients diagnosed with DVT, which demonstrated a 0.16% (3/1821) incidence of nonfatal PE in this patient population, and none of the patients received antithrombotic prophylaxis. Similar to Wang et al (3), the authors concluded DVT prophylaxis should be considered in high-risk patients (level 4 evidence).

Hanslow et al (5) conducted a retrospective analysis to determine the occurrence of VTE of surgical patients in the practices of 2 orthopedic foot and ankle surgeons over a 16-month period. Presenting symptoms, medical history, medications, history of recent air travel, tourniquet use, type of anesthetic, use of prophylaxis, immobilization, and weight-bearing status were assessed. They reported a total 4% incidence or 24 of 602 patients developing VTE. Risk factors identified were rheumatoid arthritis, recent air travel, previous DVT or PE, and limb immobilization. For patients traveling by air, the authors recommended considering venous Doppler studies after travel (level 4 evidence). This would be performed to determine the existence of a thrombus in order to initiate treatment before surgery to prevent proximal propagation.

In our case series, patient B developed a DVT 147 days after the application of the external fixator and 8 days following the fixator removal. A total contact cast was applied at this time. Although the patient was prophylaxed after the initial surgery, it was only for 14 days and she was not prophylaxed further after the second surgery. In retrospect, extended prophylaxis in this patient should have been considered due to her highly associated risk factors of malignancy and history of pulmonary embolism. She also endured a long period of non–weight bearing for a total of 159 days and as such was at increased risk for VTE.

Many patients who undergo complicated foot and ankle surgery are elderly, obese, non–weight bearing, and unable to mobilize properly with crutches or a walker. All patients in our series were overweight or obese and were non–weight bearing for a prolonged period. Furthermore, most of our patients were immobilized in a Jones compression splint and were older than 40. Each of our patients who developed VTE had at least 2 identifiable risk factors, although most patients who are treated by foot and ankle surgery have such risk factors. Despite these risk factors, patients who undergo foot and ankle surgery appear to experience symptomatic VTE in less than 1% of cases.

In conclusion, the current medical literature does not support the need for routine thromboembolism prophylaxis in patients undergoing foot and ankle surgery. Although VTE is more commonly described after proximal lower extremity procedures, our case series as well as the few reported in the literature have demonstrated that VTE can occur following foot and ankle surgery. Combining our series with the above-mentioned articles yields a total incidence of 0.83% or 53 patients with diagnosed VTE out of 6357 patients who underwent foot and ankle surgery (2, 4, 5, 12). This study, as does any retrospective review, has some limitations that are important to note. Our anticoagulation protocol in postoperative patients was not standardized with regard to the length of prophylaxis or which patients received prophylaxis. We did not conduct routine postoperative surveillance with duplex ultrasonography, and consequently, the true incidence of postoperative, asymptomatic DVT in our cohort is unknown. Currently, there are no level 1 evidence studies to support or refute prophylaxis in patients undergoing foot and ankle surgery. There are 2 level 2 studies that do not recommend routine prophylaxis after foot ankle surgery, while the studies that recommend consideration of prophylaxis are level 4 (2–4, 12). As the incidence is low, large numbers of patients would be needed to conduct a level 1 study to reach statistical significance. A multicenter prospective, randomized study would be ideal to thoroughly assess the risk factors and occurrence of venous thromboembolism following foot and ankle surgery. In patients with multiple risk factors for VTE, the risks of prophylaxis must be weighed carefully against the benefit of anticoagulation therapy. The current literature provides us with data that demonstrate that the overall risk of symptomatic, postoperative VTE in patients undergoing foot and ankle surgery is less than 1%.

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