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# PREOPERATIVE DOPPLER ULTRASONOGRAPHIC SCREENING IN TOTAL JOINT ARTHROPLASTY

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**ABSTRACT**

Venous thromboembolism represents a possible major complication following primary or revision total joint arthroplasty (TJA), especially in the lower extremities. Several international guidelines for deep venous thrombosis (DVT) prophylaxis do not recommend a preoperative lower limb duplex ultrasound evaluation before total knee or hip arthroplasty. This study aims at determining whether a preoperative doppler ultrasonographic screening represents a cost-effective complication-preventive methodology. A series of 2678 consecutive patients undergoing major hip or knee reconstructive procedures received preoperative assessment for DVT via bilateral lower limbs color doppler ultrasonography. The study group included 1697 females (63.3%) and 981 males (36.7%). Assessment included bilateral examination of common femoral, superficial femoral, popliteal, anterior tibial and posterior tibial veins. The preoperative ultrasound screening highlighted the presence of DVTs in 120 patients (4.5%). Those patients were withdrawn from the operative schedule and began DVT treatment with personalized doses of LMWH. Patients underwent knee or hip reconstructive procedures once the preoperative doppler ultrasonographic evaluation revealed absence of DVT (minimum 3 months; maximum 6 months). This study discovered a preoperative asymptomatic DVT in a consistent number of patients just before undergoing TJA procedures: without screening they were at risk of developing possible life-threatening pathologies. Therefore, we consider it prudent to perform a preoperative doppler ultrasonographic screening to detect any pre-existing DVTs, especially in patients who are considered high risk.

Key terms: DVT prophylaxis, ultrasound, TKA, THA, venous thromboembolic disease

## INTRODUCTION

Deep venous thrombosis (DVT) represents the final step of a complex interaction of events including the activation of the clotting cascade in conjunction with platelet aggregation. Patients undergoing total joint arthroplasty (TJA) are at high risk for developing a postoperative DVT and a subsequent pulmonary embolus (PE). If no prophylaxis was been used, DVT prevalence after TJA ranged from 32% to 88%.<sup>1,2,3,4</sup> Fortunately, the use of pharmacological and/or mechanical prophylaxis has reduced the complication rate to 15-30%<sup>5,6,7,8</sup>, though not eliminating the risk of a life-threatening situation. As a result, the use of venous thromboembolic prophylaxis (most commonly pharmacologic prophylaxis) has become the standard of care for patients undergoing elective TJA. However, the controversy between the efficacy of DVT prophylaxis and the increased risk for bleeding in the postoperative period continues to exist. Parvizi et al.<sup>9</sup> have shown that patients with a wound hematoma or persistent wound drainage are at higher risk for a postoperative deep joint infection, a devastating clinical situation. As a direct consequence of the concerns for postoperative bleeding risk and potential for infection, orthopedic surgeons may prefer a more risk-averse method to prevent thromboembolic phenomena following TJA, especially because the rate of symptomatic PE is similar regardless of the chemoprophylaxis agent used.<sup>10</sup>

In our experience, duplex ultrasonography has been shown to be useful in the preoperative and postoperative detection of DVT: routine screening may detect a significant percentage of asymptomatic DVT, which is not a completely benign finding.<sup>11</sup> We also believe that surveillance with duplex scanning is also fundamental in determining efficacy and duration of DVT therapy.

We performed a prospective serial duplex ultrasonography study to determine incidence of preoperative DVT and detection and clinical course evaluation of postoperative isolated distal DVT in a consecutive group of patients undergoing primary elective TJA. Our hypothesis was that performance of a preoperative and postoperative ultrasound evaluation in all patients undergoing TJA is necessary to decrease the incidence of DVT and pulmonary embolisms.

## MATERIALS AND METHODS

A prospective study including 2138 hips and 540 knees in 2678 patients undergoing elective TJA was conducted at our institute between September 2009 and December 2013. The study group included 1697 females (63.3%) and 981 males (46.7%). The Total Hip Arthroplasty (THA) study group included 153 revisions (7%), while the Total Knee Arthroplasty (TKA) group 17 revisions (3%). All patients gave informed consent.

Patients with a previous history of DVT, chronic venous insufficiency, varicose veins, renal insufficiency, heart failure, or who were taking oral steroidal/hormonal/ anticoagulant drugs for any medical condition were all included in the study.

Preoperative assessment for DVT was done in all patients on both the lower limbs by color Doppler ultrasonography using an Esaote MyLab40 device (Genova, Italy). Assessment included examination of bilateral common femoral, superficial femoral, popliteal, anterior tibial, and posterior tibial veins. Patients were assessed for flow, visualized thrombus, compressibility, and augmentation. A diagnosis of DVT was made where there was visualization of thrombosis, absence of flow, lack of compressibility or lack of augmentation. Iliac veins were not visualized and the deep femoral vein was visualized only at the junction site. Thigh veins were examined

with the patient in a supine position, and popliteal and calf veins with the patient sitting. Pulsed-wave Doppler and color Doppler modalities could be used for anatomic orientation and venous examination but not for documentation of the venous findings. Documentation comprised five video/digital sequences for each leg of approximately 60 s duration (1, thigh veins; 2, popliteal veins; 3, peroneal veins; 4, posterior tibial veins; 5, anterior tibial veins).

All patients undergoing THA were operated on using the lateral approach: a mini-posterior approach<sup>12</sup> was used in all primary THA cases (93% of all hip surgeries). All patients undergoing TKA received a standard paramedical approach<sup>13</sup>: a tourniquet was routinely used. Patients were daily assessed for any signs of DVT. All patients were given prophylaxis for DVT for 35 days postoperatively: a daily single dose low molecular weight heparin (LMWH) medication (Nadroparin 0,4 mL) was given to 32% of the patients, while a daily single dose of Fondaparinux was given to 78% of the patients. Two hundred and thirty four patients (9%) were preoperatively assuming warfarin because of a collateral pathology: patients suspended warfarin 5 days preoperatively and substituted it with a personalized dose of LMWH (“bridging Anticoagulation”).<sup>14</sup> Warfarin was resumed in the early postoperative period (48 -72 hours).

Nadroparin is a porcine-derived LMWH that binds to antithrombin III (ATIII) and accelerates the inactivation of factor II and factor Xa. Nadroparin halts the coagulation pathway by inhibiting the activation of thrombin (factor IIa) by factor Xa. The amplification of the fibrin clotting cascade is stopped once factors Xa and IIa are inactivated.

Fondaparinux (Arixtra) is a synthetic pentasaccharide anticoagulant. Apart from the O-methyl group at the reducing end of the molecule, the identity and sequence of the five monomeric sugar units contained in fondaparinux is identical to a sequence of five monomeric sugar units that can be isolated after either chemical or enzymatic cleavage of the polymeric glycosaminoglycan

heparin and heparan sulfate (HS). This monomeric sequence in heparin and HS is thought to form the high affinity binding site for the natural anti-coagulant factor, antithrombin III (ATIII). Binding of heparin/HS to ATIII has been shown to increase the anti-coagulant activity of antithrombin III 1000-fold. Fondaparinux potentiates the neutralizing action of ATIII on activated Factor X 300-fold.

All patients used an intermittent pneumatic boot compression device in the first 24 hours postoperatively, while being monitored in a sub-intensive care unit and then during the hospital stay in all non-deambulatory situations. As in the preoperative period, assessment for postoperative DVT was done by color Doppler ultrasonography on postoperative day 4. The same angiologist, who was very experienced in color Doppler ultrasonography, repeated the study in all cases. All patients wore below-knee elastic compression stockings for 35 days postoperatively. Statistical analysis was performed using Student's  $t$ -test.

## RESULTS

### PREOPERATIVE PERIOD

The preoperative ultrasound screening highlighted the presence of DVTs in 120 patients (4.5%). Those patients were withdrawn from the operative schedule and began DVT treatment with personalized doses of LMWH. Those patients underwent TJA once the preoperative color Doppler ultrasonography revealed absence of DVT (minimum 3 months; maximum 6 months).

### POSTOPERATIVE PERIOD

The incidence (Table 1) of proximal or distal DVT in patients following total knee arthroplasty was found to be 4.8% (26 patients). The incidence of proximal or distal DVT in patients

following total hip arthroplasty was 3.2% (69 patients). THA procedure showed more distal DVT (62 patients = 2.9%) than proximal DVT (7 patients = 0.3%). TKA procedure showed more distal DVT (21 patients = 3.9%) than proximal DVT (5 patients = 0.9%). No patients developed DVT in the contralateral limb.

The difference of overall DVT between groups was not statistically significant ( $p=0.35$ ). The difference of isolated distal DVT between the groups also was not statistically significant ( $p=0.71$ ). All DVTs were asymptomatic clinically.

All patients began DVT treatment with personalized doses of LMWH or Fondaparinux according to the American College of Chest Physicians (ACCP) Evidence-Based Clinical Practice Guidelines.<sup>8</sup> None of the patients had a PE in the postoperative period. Patients with acute DVT did not receive a period of bed rest but walked as soon as possible to reduce the risk of post-thrombotic syndrome. All DVT patients wore below-knee elastic compression stockings until DVT resolution, as shown by final color Doppler ultrasound. All DVT patients had color Doppler ultrasonography for DVT evolution assessment on postoperative day 30, 60, 90 and 120 if needed.

## DISCUSSION

The presence of DVT in the lower extremities following TJA is generally considered a potentially life threatening situation.<sup>15</sup> Prevention of DVT using duplex ultrasonography to avoid the complication of pulmonary embolism is effective.<sup>16</sup> The fundamental aid from preoperative color Doppler evaluation is to identify the location of a silent DVT. In fact, proximal DVTs are well known to be closely associated with increased risk of pulmonary embolism and are conventionally treated more aggressively with closer monitoring.



On the other hand, the role of distal DVT is less obvious. Although once thought to be quite benign<sup>17</sup>, distal DVT also has been reported to be associated with pulmonary embolism, especially when a distal DVT is propagated to a more proximal location<sup>18</sup>: recently Grady-Benson et al.<sup>14</sup> used serial venous Doppler flow measurements to document a propagation rate of 24% in the calf. DVT formation during TJA could be related to the flexion posture of the lower limb during the procedure or the use of a tourniquet on the thigh causing stasis or surgical trauma to the surrounding vasculature during the release.

Unfortunately, Duplex ultrasonography as a non-invasive screening tool has not yet received universal acceptance<sup>17</sup> despite promising reports.<sup>18</sup> In fact, Ko et al.<sup>18</sup> showed that preoperative Doppler ultrasonography prevents any false positive cases and forewarns the surgeon regarding the increased risk of DVT and need for prophylaxis. The preoperative ultrasound screening demonstrated a DVT in 4.5% of our patients: without screening they were at risk of developing a perioperative pulmonary embolism. Therefore, the authors of the current study believe it is prudent to do preoperative Doppler ultrasonography to detect any pre-existing DVT, especially in patients who are considered at high risk as shown in Table 2 (old age, BMI>30, history of venous thromboembolism, revision joint surgery, congestive heart failure, chronic rheumatic heart disease, steroid/hormonal/anticoagulant therapy, varicose veins, prolonged immobilization, malignancy, factor V Leiden, etc.). In fact, preoperative and postoperative clinical findings alone are generally considered poor predictors of the presence of DVT.<sup>19</sup> Once a DVT episode has been detected, surveillance with duplex scanning also is mandatory in determining efficacy and duration of therapeutic anticoagulation for DVT.<sup>20,21</sup>

Our study does not specifically address the issue of indication and timing of initiation of anticoagulation therapy for patients undergoing TJA. Although the value of routine

pharmacologic thromboprophylaxis in TJA has been questioned by metanalysis<sup>22</sup>, the majority of surgeons would still recommend some form of prophylaxis against DVT<sup>7</sup> in view of the morbidity and mortality associated with postoperative DVT in THA and TKA. The authors of the current study recognize that venous thromboembolic events following primary hip and knee arthroplasty have decreased significantly over the past two decades mainly due to a multidisciplinary approach. Rapid postoperative mobilization, optimization of surgical technique, and improved perioperative pain management (including the use of regional anesthesia) have all contributed to decreasing the DVT risk. At the author's institution, we use pharmacologic and mechanical approaches for thromboprophylaxis after TJA as suggested by the 2012 American College of Chest Physicians (ACCP) Evidence-Based Clinical Practice Guidelines<sup>12</sup> and the 2009 Tuscany Region Protocol for Thromboprophylaxis in Orthopaedic Surgery ([www.regione.toscana.it](http://www.regione.toscana.it)). All patients undergoing a TJA procedure receive a form of pharmacologic thromboprophylaxis (low-molecular-weight heparin or fondaparinux) for 35 days postoperatively, use an intermittent pneumatic compression device during the hospital stay, and wear below knee elastic compression stockings for 35 days postoperatively. The main difference from 2012 ACCP guidelines<sup>12</sup> was that all our patients underwent Doppler ultrasonography screening preoperatively and postoperatively before hospital discharge. Doppler ultrasonography is historically a non-invasive procedure and provides good sensitivity (89%) and specificity (100%) for detecting DVT.<sup>4</sup> There is a lack in the literature on the appropriateness of preoperative Doppler ultrasonography in patients undergoing TJA: Sisodia et al.<sup>23</sup> recently reported 22.4% preoperative asymptomatic DVTs in a group of patients awaiting TJA. The current study supports the benefit of Doppler ultrasonography as a preoperative and postoperative investigation method in patients undergoing TJA.

## REFERENCES

1. Brookenthal KR, Freedman KB, Lotke PA et al (2001) A meta-analysis of thromboembolic prophylaxis in total knee arthroplasty. *J Arthroplasty* 16:293–300
2. Clagett GP, Anderson FA, Heit J et al (1995) Prevention of venous thromboembolism. *Chest* 108:312S–334S
3. Clarke MT, Green JS, Harper WM et al (1997) Screening for deep vein thrombosis after total hip and knee replacement without prophylaxis. *J Bone Joint Surg [Br]* 79:787–791
4. Cronan JJ, Dorfman GS, Scola FH et al. (1987) Deep venous thrombosis: US assessment using vein compression. *Radiology* 162:191–4.
5. Davidson BL, Elliott CG, Lensing AW. (1992) Low accuracy of color Doppler ultrasound in the detection of proximal leg vein thrombosis in asymptomatic high-risk patients. The RD Heparin Arthroplasty Group. *Ann Intern Med* 1992;117:735–8.
6. Doouss TW (1976) The clinical significance of venous thrombosis of the calf. *British J Surg* 63:377–378
7. Francis CW, Pellegrini VD Jr, Totterman S et al (1997) Prevention of deep-vein thrombosis. *J Bone Joint Surg [Am]* 9:1365–1372
8. Gordon H, Guyatt, Elic A., Mark Crowther et al. (2012) Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines *Chest*. 2012;141(2\_suppl):1S. doi:10.1378/chest.1412S1
9. Grady-Benson JC, Oishi CS, Hanson PB et al (1994) Postoperative surveillance for deep vein thrombosis with duplex ultrasonography after total knee arthroplasty. *J Bone Joint Surg [Am]* 11:1649–1657
10. Ko P.S., Chan W.F., Siu T.H. et al. (2003) Duplex ultrasonography after total hip or knee arthroplasty. *International Orthopaedics (SICOT)* 27:168–171

11. Lieberman JR, Pellegrini VD. (1999) Orthopaedic knowledge update 6. Rosemont: American Academy of Orthopaedic Surgeon.
12. Marcucci M, Indelli PF, Latella L, Poli P, King D: “A multimodal approach in total hip arthroplasty preoperative templating”. *Skeletal Radiology* (2013) 42 (9): pp 1287-1294.
13. Indelli PF, Marcucci M, Pipino G, Charlton S, Carulli C, Innocenti M. “The effects of femoral component design on the patello-femoral joint in a PS total knee arthroplasty”. *Arch Orthop Trauma Surg.* 2014 Jan; 134 (1):59-64.
14. Lohr JM, James KV, Deshmukh RM et al (1995) Calf vein thrombi are not a benign finding. *Am J Surg* 170:86–90
15. Lotke PA, Steinberg ME, Ecker ML (1994) Significance of deep vein thrombosis in the lower extremity after total joint arthroplasty. *Clin Orthop* 299:25–30
16. Masuda EM, Kessler DM, Kistner RL et al. (1998 )The natural history of calf vein thrombosis: lysis of thrombi and development of reflux. *J Vasc Surg.*28(1):67-73; discussion 73-4.
17. McKenna R, Bachmann F, Kaushal SP et al (1976) Thromboembolic disease in patients undergoing total knee replacement. *J Bone Joint Surg [Am]* 58:928–932
18. Murray DW, Britton AR, Bulstrode CJ (1996) Thromboprophylaxis and death after total hip replacement. *J Bone Joint Surg [Br]* 78:863–870
19. National Institutes of Health Consensus Development Conference statement (1986) Prevention of venous and pulmonary thromboembolism. *JAMA* 256:744–749
20. Parvizi J, Ghanem E, Joshi A et al. (2007) Does “excessive” anticoagulation predispose to periprosthetic infection? *J Arthroplasty* 22(6 Suppl 2):24–8.
21. Planes A, Samama MM, Lensing AW et al (1999) Prevention of deep vein thrombosis after hip replacement. *Thromb Haemost* 81:22–25

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22. Stulberg BN, Insall JN, Williams GW et al (1984) Deep vein thrombosis following total knee replacement. An analysis of six hundred and thirty-eight arthroplasties. *J Bone Joint Surg [Am]* 66:194–201
  23. Sisodia G, Garnet Fernando WS, Melton C, et al.(2013): The incidence of pre-operative asymptomatic DVT among patients awaiting total knee arthroplasty or total hip arthroplasty.  
<http://www.nlg.nhs.uk/services/radiology/The.incidence.of.preop.DVT.in.patients.awaiting.TKR.and.THR.pdf> . Accessed 12/22/13
  24. Westrich GH, Haas SB, Mosca P et al. (2000) Meta-analysis of thromboembolic prophylaxis after total knee arthroplasty.. *J Bone Joint Surg Br.* 82(6):795-800.

## 1) Table 1:

Incidence and location of ultrasonographically confirmed postoperative deep vein thrombosis (DVT). *TKA* total knee arthroplasty; *THA* total hip arthroplasty

Arthroplasty Type	No. Patients	Proximal DVT	Distal DVT	Total DVT
TKA	540	5 (0.9%)	21 (3.9%)	26 (4.8 %)
THA	2138	7 (0.3%)	62 (2.9 %)	69 (3.2 %)
Total	2678			

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## 2) Table 2

## High risks factors for deep vein thrombosis (DVT)

- Old age
- BMI>30
- History of venous thromboembolism
- Revision joint surgery
- Congestive heart failure
- Chronic rheumatic heart disease
- Steroid/hormonal therapy
- Anticoagulant therapy
- Varicose veins
- Prolonged immobilization
- Malignancy
- Factor V Leiden