

Duplex ultrasound surveillance for asymptomatic deep venous thrombosis after total knee joint replacement

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Abstract:

Background: The prevalence of deep veins thrombosis, complicating total knee replacement in Asian countries, has not been fully appreciated in comparison to western countries as there are few studies on that. There is an important correlation between the evidence of deep veins thrombosis in the lower extremity and likelihood of pulmonary embolism later on. Because of its noninvasive nature, duplex ultrasound has become one of the initial dependable modality for the check out of deep veins thrombosis after total knee replacement. Therefore, this study was designed to evaluate the outcome of asymptomatic after total knee replacement by duplex ultrasound among Iraqi patients.

Methods: This prospective study was conducted at AL-Shaheed Gazi AL-Hariri specialized Surgical Hospital, Radiology department, Ultrasound unit from October 2009 to October 2010. Duplex ultrasound surveillance for asymptomatic deep venous thrombosis was done on 30 patients (13 females and 17 males) who had undergone total knee replacement at day 5-7 postoperatively to investigate the evidence of deep venous thrombosis after total knee joint replacement among Iraqi patients.

Results: The percentage of deep veins thrombosis in this study was found to be 23.33%. Of these, 14% occurred in the popliteal and 86% occurred in the calf vein. Patients' gender was not associated with significant higher incidence of deep veins thrombosis. Although the incidence of deep veins thrombosis in patients aged more than 50 years was higher than in patients aged 30-50 years, it did not reach a statistically significant level. There was statistically significant relationship between obesity and the development of deep veins thrombosis. Patients with sedentary lifestyle showed higher incidence of deep veins thrombosis than patients with non-sedentary lifestyle and the difference reached a statistically significant level. The duration of the operation showed a significant correlation with the incidence of deep veins thrombosis when the operation lasted more than 2 hours. In addition, there was higher incidence of deep veins thrombosis among smokers compared to non-smokers.

Conclusion: The evidence of deep veins thrombosis was 22.33% in spite of anticoagulation coverage. Also, duplex ultrasonography is suggested after total knee replacement, especially in patients who have other risk factors.

Keywords: Duplex ultrasound, deep veins thrombosis, knee joint replacement, Iraqi patient.

Introduction:

Venous blood is drained from the lower limb by a system of deep, superficial and perforators venous circulation in which the antegrade flow of blood within the lower extremity veins is directed by a

system of muscular venous pumps and bicuspid valves (1). A system of valves which are more common in the superficial than in the deep keeps the flow always toward the heart when the patient is in standing position (2). The fate of deep veins thrombosis (DVT) in lower limbs is simple and commonly affect the valve leaflet which is considered the elective site for thrombi formation. Most of them occur at calf veins and about 40% will resolve spontaneously, another 40% will become organized and only 20% will actually propagate (3). Venous stasis alone is not considered as a major and

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enough cause for venous thrombosis (4). High risk patients for developing DVT are those having long period of immobilization (5). Mechanical injury to the vein provides added stimulus for venous thrombosis as endothelial injury can convert the normally antithrombogenic endothelium to become prothrombotic by stimulating the production of tissue factor, von Willebrand factor and fibrinogen (6). Genetic mutations within the blood's coagulation cascade represent those at high risk for the development of venous thrombosis as 5-10% of all thrombotic events may be due to primary deficiency of antithrombin inhibitors also protein C and protein S (6). Many factors have been identified as risk factors for development of venous thrombosis including hypercoagulable states, deficiencies of protein C and protein S, age, obesity, hypertension, cigarette smoking, history of heart disease and diabetes mellitus (7). Also, females take oral contraceptive pills and chemotherapy may increase the risk of venous thrombosis by affecting the vascular endothelium, coagulation cascades and tumor cell lysis (8, 9). Histological examination of vein's wall has demonstrated an imbalance in tissue matrix regulation and a loss of regulatory venous contractility that contribute to the development of chronic venous insufficiency (10). Criteria used by Doppler ultrasound of diagnosis DVT include: 1. Visible thrombus in the lumen of thrombosed vein causing interruption of color flow, 2. compressibility of the vein as normal vein is compressible while the thrombosed vein is either partially compressible or incompressible, and 3. Flow in the normal vein is showing full color saturation and continuous while thrombosed vein shows partial or no flow (3).

Patients and Methods:

This prospective study was conducted at Al-Shaheed Gazi Al-Hariri teaching hospital, Medical city teaching complex, Baghdad, Iraq, from October 2009 to October 2010. According to patients' age, the patients were divided into two groups; those between 30 to 50 years who considered young age group and those above 50 years which considered old age group, they had undergone total knee replacement for osteoarthritis under general anesthesia and all operations were performed with tourniquet control for about 15 minutes with the same surgical technique. Exclusion criteria included: previous history of DVT, history of coagulopathy and patients with varicose veins. Thirty one patients were referred from orthopedic department. Only one male patient aged 45 years had history of DVT, so this patient was excluded from the study. Duplex ultra-sonography of lower limbs venous system was conducted on 30 patients. Preoperative work up included complete blood count, coagulation and chemistry profile (all of them had normal pre-operative laboratory tests). All patients received enoxaparin (low

molecular weight heparin) at a dose of 4000IU subcutaneously six hourly after surgery for 2 weeks from the operation. All patients were managed postoperatively with the same protocol which included besides continuous passive motion, physiotherapy with partial weight bearing on the operated limb, routine duplex sonography was performed 5-7 days postoperatively for both lower limbs. The equipment used in the examination was high-resolution real-time sound (Siemens –Sonoline-Elegra) using linear transducer of 7.5 MHz. A peripheral venous scanning option was selected before starting the examination, the system was set up for venous preset rather than arterial preset to detect flow of lower velocities. There was usually no special preparation required before a lower limb duplex scan. The examination was done first using B-mode imaging then Color Doppler & spectral Doppler. Scanning was performed with the patient lying in supine position and his/her affected leg was moved laterally to examine the popliteal region. The examination begun in supine position by examining the common femoral vein at the groin to its bifurcation then superficial femoral vein was examined in its proximal, middle, and distal portions. Then, patients was turned into a lateral decubitus position to examine the popliteal vein. The calf veins were then examined and the posterior tibial vein & deeper peroneal veins were located by scanning in the transverse or longitudinal plane from the medial side of the mid-calf area behind the tibia. The deep peroneal veins were also visualized deep to the interosseous membrane from anterolateral aspect if cannot be identified from a posteromedial approach. The interior tibial veins were examined from an anterolateral approach: scanning transversely, tibia, fibula and interosseous membrane are identified, the anterior tibial veins are found on the superficial aspect of interosseous membrane. The normal vein lumen is anechoic on grayscale with complete color fill on color Doppler ultrasound or power Doppler ultrasound. A vein containing fresh thrombus is relatively anechoic & tends to expand the vein lumen slightly, so the thrombus may be missed on gray scale study but show partial fill on color Doppler ultrasound or power Doppler ultrasound. Then compression of the vein was done in transverse plane as normal veins are completely compressible so that the lumen is obliterated with only light or moderate pressure from the transducer, and must be done during ordinary ultrasound and color Doppler examination, whereas the thrombosed vein is partially or completely incompressible as the thrombus will hold the vein walls in position. Then, the flow in the lower limbs veins was assessed with color and spectral Doppler study, normal veins showed spontaneous, continuous flow & show respiratory variation with dilation of the veins on Valsalva maneuver.

Augmentation may be used to increase flow in all of the major veins of the lower extremity during squeezing of calf muscles. When augmentation could not be performed for any reason such as bandages, Valsalva maneuver was found useful as with Valsalva maneuver, during breath hold venous return to the heart is decrease and when breath hold was released by the patients, there will be sudden increase in the venous return which was seen as change in waveform as well as heard as auditory sound like wind tunnel.

The data were recorded and statistical analysis was done. Patients were classified according to their body Mass index as follows:

Body Mass Index (BMI) = (kg) / height² (meter).

BMI= 19.9 (underweight).

BMI = 20-24.9 (normal weight).

BMI= 25-29.9 (over weight).

BMI = 30 -40 (obese)

BMI = 40 (morbid obesity).

Patients were classified according to their life style as follow: anyone who had a job that needs sitting down for a long period, people using a lift instead of the stairs, those using their cars travelling short distances and those who do not participate in any physical activities can be deemed to have a sedentary life style. Patients were classified according to their smoking habits as follows: non-smokers, smokers who smoke up to one pack per day and heavy smokers who smoke about two to three packs per day.

Statistical analysis:

Data were analyzed by using Statistical Package for Social Science (SPSS) program version 22.0. The descriptive statistics were used to find the percentages and frequencies for categorical variables. Chi-squared test was performed for the association between categorical variables. A P-value of less than 0.05 was considered statistically significant.

Results

Table 3: Association between DVT status and age groups

Age group	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
30 – 50 years	7/9	77.8	2/9	22.2	9/30	30.0	0.051
> 50 years	16/21	76.2	5/21	23.8	21/30	70.0	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

DVT: Deep Venous Thrombosis

Table (4) the current study had 13 patients of female gender (43.3%) and 17 patients of male gender (56.7%). Out of 13 female patients, 3 patients (23.5%) had DVT. Out of 17 male patients, 4 patients (23.5 %) had DVT. In another word, out of the 7 patients who developed DVT, 4 patients (57.2%) were males and 3 patients

Table (1) thirty patients had duplex ultrasonographic studies performed on day 5-7 postoperatively. The prevalence of DVT was found to be 23%, in which 6 out of 7 patients (85.7%) had the DVT in the distal vein (Calf vein), while 1 out of 7 patients (14.3%) had the DVT in the proximal vein (Popliteal vein). However, there was no DVT seen at the femoral or iliac vein.

Table 1: Prevalence and location of DVT on Doppler ultrasound

Variable	No. of patients	%
*DVT		
Negative	23	76.67
Positive	7	23.33
Location		
Calf vein	6	85.7
Popliteal vein	1	14.3
Femoral vein	0	0.0
Iliac vein	0	0.0

*Deep Venous Thrombosis.

Table (2) showed the distribution of DVT according to the affected side, 6 out of the 7 patients (85.7%) had developed DVT on the operated side, whereas 1 out of the 7 patients (14.3%) had developed DVT on the contralateral side.

Table 2: Distribution of DVT by affected side

Affected side	No. of patients	%
Operated side	6	85.7
Contralateral side	1	14.3
Total	7	100.0

Table (3) showed that out of the 30 patients included in this study, 9 patients (30 %) were within age group 30-50 years and 21 patients (70%) were within age group more than 50 years. From seven patients who developed DVT, five patients (71.4%) were within the age group more than 50 years and only 2 patients (28.6%) were within the age group 30-50 years reflecting a higher incidence among older patients. This indicated that there was no significant association between age groups and DVT (P=0.051; Table 3).

(42.8 %) were females. Thus, the association between DVT and gender was not found to be statistically significant (P=0.061; Table 4).

Table 4: Association between DVT status and patients gender

Gender	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
Female	10/13	76.9	3/13	23.0	13/30	43.3	0.061
Male	13/17	76.5	4/17	23.5	17/30	56.7	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

Table 5 showed that among those with normal BMI, there was no patient reported to have DVT (0.0%). Moreover, the prevalence of DVT was noted to be higher in obese patients (33.4%) compared to those who

have an overweight (26.7%). Hence, the DVT was found to be significantly associated with BMI ($P=0.041$; Table 5)

Table 5: Association between DVT status and patients' body mass index

Body mass index	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
Normal	6/6	100.0	0/6	0.0	6/30	20.0	0.041
Overweight	11/15	73.3	4/15	26.7	15/30	50.0	
Obese	6/9	66.6	3/9	33.4	9/30	30.0	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

Table (6) the study population included 20 patients (66.7%) in whom the duration of operation lasted less than 2 hours and 10 patients (33.3%) in whom duration of operation lasted more than 2 hours. Out of the 20 patients with duration of operation less than 2 hours ,4 patients (20%) developed DVT. Out of 10 patients with duration of operation more than 2 hours, 3 patients (30%) developed DVT. The difference in the incidence between the two groups reached statistically significant value (Table 6).

Table 6: Association between DVT status and duration of operation

Duration of operation	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
< 2 hours	16/20	80.0	4/20	20.0	20/30	66.7	0.043
≥ 2 hors	7/10	70.0	3/10	30.0	10/30	33.3	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

DVT: Deep Venous Thrombosis

Table (7) showed that the study population included 21 patients (70%) with sedentary life style and 9 patients (30%) with non-sedentary life style. Out of the 21 patients with sedentary life style, 6 patients (28.6%) developed DVT. Out of the 9 patients with non-sedentary life style only 1 patient (11.1%) developed DVT. This reflected a higher incidence of DVT in patients with sedentary life style, the difference reached a statistically significant value (Table 7).

Table 7: Association between DVT status and sedentary status

Sedentary status	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
Sedentary patients	15/21	71.4	6/21	28.6	21/30	70.0	0.026
Non-sedentary patients	8/9	88.9	1/9	11.1	9/30	30.0	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

Table (8) showed that the study population included 12 non-smoker patients (40%), 12 smoker patients (40%) and 6 heavy smoker patients (20%). Out of 12 non-smoker patients, 2 patients (16.7%) developed DVT. Out of 12 smoker patients, 3 patients (25%) developed DVT. Out of 6 heavy smoker patients, 2 patients (33.3%) developed DVT. The difference in the incidence of DVT between smoker and non-smoker was found to be statistically significant (Table 8).

Table 8: Association between DVT status and smoking status

Smoking status	DVT status				Total	%	P - value
	No DVT	%	With DVT	%			
Non-smoking	10/12	83.3	2/12	16.7	12/30	40.0	0.015
Smoking	9/12	75.0	3/12	25.0	12/30	40.0	
Heavy smoking	4/6	66.7	2/6	33.3	6/30	20.0	
Total	23/30	76.7	7/30	23.3	30/30	100.0	

Discussion:

The purpose of surveillance for DVT after total knee joint arthroplasty is to identify patients with high risk of thrombosis and therefore need to continue using anticoagulation therapy and those patients who do not have risk of thrombosis might not need to continue anticoagulation therapy. In reality, no prophylaxis provides complete protection against thromboembolic disease and, therefore, every treatment strategy represents a balance between relative risks and benefits. Thus, prompt recognition of venous thrombosis at time of discharge is essential to the strategy of post discharge anticoagulation therapy (11). The total number of the patients examined in the current study was thirty, seven (23.33%) of them had developed DVT. Of those with DVT, a higher prevalence was observed in the operated limb (85.7%) as compared with contralateral limb (14.3%). When a sub-analysis was done, the distal vein (Calf vein) had the highest prevalence of DVT (85.7%) whereas proximal vein (Popliteal vein) had the lowest (14.3%). A previous study by William J et al. (1998) (12) revealed that prevalence of DVT was a bit higher (27%) than that in the present study. Nevertheless, a recent study by Tateiwa et al. (2019) (13) from Japan showed that the prevalence of postoperative DVT was much higher (62.5%) than that in our study. This might be attributed to postoperative DVT medications used in Iraq, whereas no such medications are used in Japan. Regarding DVT location, several previous and recent studies (12-15) were compatible with the present study in that distal DVT of the operated limb was noted to be the highest while proximal DVT was the lowest. A high prevalence of DVT in the distal veins (Calf veins) may be attributed to the fact that the current methods of prophylaxis had altered the natural distribution of DVT and were more effective in preventing thrombosis in the thigh than in the calf (12,15). The previous studies confirmed that the prevalence of DVT increased with age (8,9). A very recent study by Eric Swanson revealed a significant positive correlation between DVT and advanced age (16). A high prevalence of DVT among old ages might be attributed to the fact that old people are likely to have other risk factors for thrombosis (e.g. restricted movement, heart disease, etc.). Unexpectedly, our findings did not find a significant association between age and DVT despite that the prevalence of DVT was found to be 23.8% among patients aged >50 years compared to those within age group 30 – 50 years (22.2%). This may be due to the small sample size recruited in the present study. It's well documented that there is no sex difference in the incidence of DVT, except in women using oral contraceptive pills (17,18). The results of current study agreed with this as there was no statistically significant difference in the incidence of DVT between males and females who participated in current study with incidence in both genders of about 23%. In the current study, none of the

patients with normal body weight developed DVT compared to 26.7% of overweight patients and 33.4% of obese patients who developed DVT. This reflected the fact that the risk of DVT increases with increasing weight of the patients and this is probably because obesity may be associated with longer period of immobility postoperatively than non-obese patients and the longer the duration of operation in obese patients (19). The duration of the operation was found to be a risk factor for development of DVT (20). In our study, 20% of patients with duration of operation less than 2 hours developed DVT and 30% of patients with duration of operation more than 2 hours developed DVT. This difference was found to be statistically significant. In current study there was a statistically significant difference in the incidence of DVT between patients with sedentary life style (28.6%) and those with non-sedentary life style (11.1 %). These results agreed with results obtained by Nathan et al. (2003)(15) who also found that sedentary life style was a risk factor for DVT because without muscles contractions blood flow slows down and becomes more prone to clotting. In the current study, smoking was found to be a statistically significant risk factor for development of DVT, as (16.7 %) of the non-smokers developed DVT while 25% of the smokers and 33% of the heavy smokers patients developed DVT. Similar results were achieved by Stulbrg et al. () As smoking changes the surface of blood platelets, making it easier for them to clump together, it also causes damage to the lining to the blood vessels walls, both of these increase risk of thrombosis. In this study, body weight of patients, duration of operation, life style of the patients and the smoking were found to be risk factors for DVT while gender and age of the patient were found to be none statistically significant risk factor for DVT.

Conclusion

This study concluded that the prevalence of DVT was 23.33% in this study in spite of anticoagulant cover. In addition, the prevalence of DVT increases with aging in both females and males with no gender difference. It is also noted that the prevalence of DVT increases in overweight and obese patients when the duration of operation is long. The smoking and sedentary lifestyle could increase the risk of DVT.

Ethical Clearance for the study

Ethical clearance was obtained from Educational Medical City Department, Training and Human Development Center, Ministry of Health, Baghdad.

Conflict of interest

There is no conflict of interest

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الفحص بالموجات فوق الصوتية للتخثر الوريدي العميق الغير مصحوب باعراض بعد الاستبدال الكامل لمفصل الركبة

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الخلاصة:

لم يتم تقدير حدوث تخثر الأوردة العميقة ، الذي يعتبر احد مضاعفات عملية الاستبدال الكامل لمفصل الركبة في الدول الآسيوية مقارنة بالدول الغربية حيث توجد دراسات قليلة حول ذلك. هناك علاقة ارتباط مهمة بين حدوث تخثر الأوردة العميقة في الاطراف السفلي واحتمال الإصابة بالانسداد الرئوي لاحقاً. بما ان الفحص بالموجات فوق الصوتية غير جراحي ، أصبح إحدى الطرق الأولية التي يمكن الاعتماد عليها لفحص تخثر الأوردة العميقة بعد الاستبدال الكامل للركبة. لذلك صممت هذه الدراسة لتقييم نتيجة استبدال مفصل الركبة الكامل الغير مصحوب باعراض بالموجات فوق الصوتية بين المرضى العراقيين.

طريقة البحث: أجريت هذه الدراسة المستقبلية في مستشفى الشهيد غازي الحريري للجراحات التخصصية في قسم الأشعة ، وحدة الموجات فوق الصوتية من أكتوبر 2009 إلى أكتوبر 2010. تم إجراء الفحص بالموجات فوق الصوتية للتخثر الوريدي العميق الغير مصحوب باعراض على 30 مريضاً (13 إناث و 17 ذكور) الذين خضعوا لاستبدال مفصل الركبة بالكامل في اليوم 5-7 بعد الجراحة لملاحظة تخثر الدم الوريدي العميق بعد استبدال مفصل الركبة بالكامل بين المرضى العراقيين

النتائج: تبين ان نسبة تخثر الأوردة العميقة في هذه الدراسة 23.33%. من بين هؤلاء 14% حدثت في الوريد المأبضي و 86% حدثت في وريد ريلة الساق. لم تكن هناك علاقة بين جنس المريض و تخثر الأوردة العميقة. بالرغم من أن معدل حدوث تخثر الأوردة العميقة في المرضى الذين تزيد أعمارهم عن 50 عاماً كان أعلى منه في المرضى الذين تتراوح أعمارهم بين 30-50 عاماً ، إلا أنه لم يصل إلى مستوى ذي دلالة إحصائية. كانت هناك علاقة ذات دلالة إحصائية بين السمنة وتطور تخثر الأوردة العميقة. أظهر المرضى الذين يعانون من نمط الحياة المستقرة معدل حدوث تخثر الأوردة العميقة أعلى من المرضى الذين يعانون من نمط حياة غير مستقرة ووصل الفرق إلى مستوى ذي دلالة إحصائية. أظهرت الدراسة ان مدة اجراء العملية يرتبط ارتباطاً مهماً بحدوث تخثر الأوردة العميقة عندما استغرقت العملية أكثر من ساعتين. بالإضافة إلى ذلك ، كانت هناك نسبة أعلى من تخثر الأوردة العميقة بين المدخنين مقارنة بغير المدخنين

الاستنتاج: نسبة حدوث تخثر الأوردة العميقة كان 22.33% على الرغم من اعطاء ادوية منع تخثر الدم. أيضاً ، يُوصى باستخدام التصوير بالموجات فوق الصوتية بعد الاستبدال الكامل للركبة ، خاصة في المرضى الذين لديهم عوامل خطرة أخرى.

الكلمات المفتاحية : الموجات فوق الصوتية المزدوجة ، تجلط الأوردة العميقة ، استبدال مفصل الركبة ، المرضى العراقيين