



Review Article

Role of Color Doppler Ultrasound to Evaluate the Lower Limb Deep Venous Thrombosis in Diabetic Patients

Muhammad Ahmad Raza^{1*}, Abdul Rauf², Bushra Akmal Khan³, Muhammad Asad Alam¹, Laamia Altuf⁴, Aftab Alloudin¹ and Saman Fatima⁵

¹University Institute of Radiological Sciences and MIT, The University of Lahore, Lahore, Pakistan

²Foundation University School of Health Sciences, Islamabad, Pakistan

³Hayatabad Medical Complex, Peshawar, Pakistan

⁴Department of Radiological Sciences and MIT, Superior University, Lahore, Pakistan

⁵The University of Lahore, Lahore, Pakistan

ARTICLE INFO

Key Words:

Deep Vein Thrombus, Diabetes Mellitus, Color Doppler Ultrasound

How to Cite:

Raza, M. A., Rauf, A., Khan, B. A., Alam, M. A., Altuf, L., Alloudin, A., & Fatima, S. (2024). Role of Color Doppler Ultrasound to Evaluate the Lower Limb Deep Venous Thrombosis in Diabetic Patients : Color Doppler Ultrasound for Lower Limb Deep Venous Thrombosis . Pakistan Journal of Health Sciences, 5(01). <https://doi.org/10.54393/pjhs.v5i01.1229>

*Corresponding Author:

Muhammad Ahmad Raza
University Institute of Radiological Sciences and MIT,
the University of Lahore, Lahore, Pakistan
dr.ahmad663@gmail.com

Received Date: 15th December, 2023

Acceptance Date: 20th January, 2024

Published Date: 31st January, 2024

ABSTRACT

Diabetes mellitus is one of the main risk factors for peripheral arterial disease (PAD), and its occurrence is on the rise. In patients with deep vein stenosis, it is quite prevalent. Deep vein thrombosis is a serious health issue in the United States that impacts more than 2.5 million individuals each year. We searched a variety of search engines and databases, including Google Scholar, PubMed, and NCBI, for papers pertaining to our subject. Data on the assessment of lower limb DVT in diabetic patients were extracted from just 20 articles. The current study examined the assessment of DVT in the lower leg. Individuals with diabetes experience different rates of deep vein thrombosis. The result is not statistically significant. The anatomic location of the thrombus indicated that patients with diabetes had a higher likelihood of involvement of the popliteal vein, femoral vein, and common femoral vein compared to non-diabetics.

INTRODUCTION

Diabetes mellitus (DM) is one of the main risk factors for peripheral arterial disease (PAD), and its occurrence is on the rise. Those with deep vein stenosis have a relatively high prevalence of it [1]. Deep vein thrombosis is a serious health issue that impacts more than 2.5 million individuals each year. Pulmonary embolism (PE), the most dangerous side effect of a deep vein thrombosis (DVT), is linked to 50,000–200,000 fatalities annually. Although PE and DVT are sometimes quiet and challenging to identify through a clinical examination [2]. With a history of DVT who also have diabetes had a much greater frequency of

symptomatic atherosclerotic plaques, indicating a potential overlap in the pathophysiology of both conditions. Furthermore, epidemiological research has demonstrated the connection between venous and arterial thrombosis, primarily emphasizing the existence of shared risk factors [3]. Lower extremity atherosclerotic occlusive disease is a hallmark of peripheral arterial disease (PAD). Diabetes mellitus, cholesterol, and hypertension are associated with an increased risk of PAD. Due to systemic atherothrombosis, PAD is a significant risk factor for coronary and cerebrovascular events, such as myocardial

infarction, stroke, and mortality. Advanced age, cigarette smoking, diabetes mellitus (DM), cholesterol, and hypertension are associated with high risk of PAD. Due to systemic atherosclerosis, PAD is a significant risk factor for coronary and cerebrovascular events. Rarely is PAD a standalone illness; rather, it is a symptom of systemic reduce blood flow. In individuals with DM, PAD is three to four times more common, more widespread, and less symptomatic than in normal persons. Notably, early diagnosis of asymptomatic PAD in patients with DM has crucial consequences, as the risk of limb amputation owing to PAD is much greater in this patient population [4]. It is frequently challenging to detect lower extremity acute deep vein thrombosis (DVT). Only half of individuals with DVT symptoms and signs have thrombi, while up to two thirds of venous thrombi are asymptomatic. Pulmonary embolism, a major cause of morbidity and death for hospitalized patients, can arise from an undetected deep vein thrombosis. Numerous studies have demonstrated compression ultrasonography's (US) better accuracy in the detection of acute DVT [5]. Due to a variety of risk factors not being sufficiently taken into account and differences in the expertise of doctors, deep vein thrombosis (DVT) is not properly controlled in the clinical results of patients. Consequently, to more successfully avoid the development of DVT. Depending on where thrombus development occurs, lower limb DVT may be divided into two categories: proximal deep vein thrombosis and distal deep vein thrombosis. The incidence of adverse events in

DDVT cases is much lower than in PDVT cases [6]. Doppler offers a more accurate assessment of the hemodynamic importance of occlusive illness and is noninvasive, portable, and quick to perform [7]. A non-invasive, practical, and non-radioactive vascular test that can reliably and efficiently represent limb vascular status is doppler ultrasonography. Numerous academics have started looking into the lower extremity DVT risk factors. The period of thrombosis and the danger of thrombus detachment are associated, and ultrasonography elastography is a reliable way to find out when DVT forms. This approach has a danger, too, since it might cause the thrombus to come off when the DVT is being examined. As a result, a more precise and safe approach is needed to assess DVT stability. Vibrance Doppler ultrasonography may be a better option for identifying DVT stability because of its high accuracy and ease. Furthermore, thrombus formation and progression are impacted in several ways [8].

METHODS

Different search engines, databases like Google scholar, PubMed, NCBI were used to search the articles related to our topic. The search on databases & search engines identified 39 articles related to topic, among which only 26 articles were as per requirement. And 6 articles were discussing other different pathologies that was not related to statement. Finally, 20 articles were found eligible to carry review forward with them.

RESULTS

Only 20 articles were used for extraction of data related to role of color Doppler ultrasound in the evaluation of lower limb DVT in diabetic patients. The current study looked at color Doppler ultrasound used for lower limb DVT evaluation (Table 1, Figure 1 and 2).

Table 1: Summary of Included Studies

Study Name	Country	Objective	Findings
[1]. Ballotta et al., 2014	Italy	To evaluate lower extremity arterial reconstruction for diabetic critical limb ischemia.	The survival and amputation-free survival rates of diabetes individuals undergoing lower extremity artery reconstruction for critical limb ischemia can be comparable to those of non-diabetic patients. They clearly show that diabetics with critical limb ischemia can anticipate the same quantity and quality of life as nondiabetics based on their equivalent technical and clinical outcomes.
[2]. Aquila et al., 2001	Connecticut	To evaluate deep vein thrombosis in relation to various risk factors.	If DVT occurs, being aware of individuals who are at risk and informed about the symptoms and indicators of the condition can enable quick diagnosis, treatment, and patient education.
[3]. Kremers et al., 2019	Netherlands	To clarify how neutrophils and coagulation contribute to atherothrombotic episodes in individuals who have had peripheral artery disease or deep vein thrombosis in the past.	Neutrophil activity does not seem to be a significant driver in DVT patients. Furthermore, no correlations between NET products and coagulation activity were discovered, indicating that neutrophil activation is not a major factor in the risk of thrombosis in DVT or PAD.

[4]. Hur et al., 2018	Korea	To examine peripheral artery disease in type 2 diabetes may be diagnosed using color Doppler ultrasonography.	Color Doppler ultrasound revealed multivessel involvement, bilateral lesions, and stenosis. Moreover, Color Doppler ultrasonography is a helpful method for identifying PAD in individuals with type 2 diabetes.
[5]. Lewis et al., 1994	Minnesota	To evaluate the usefulness of color Doppler flow imaging in the non-venous compression detection of deep vein thrombosis (DVT) in the femoropopliteal system.	For the assessment of suspected acute DVT, color Doppler flow imaging is a useful adjunct to compression ultrasonography. It can also be useful for individuals who have had chronic or prior DVT for the examination of suspected DVT.
[6]. Yao et al., 2023	China	To evaluate the creation and validation of a risk nomogram for geriatric patients with hip fractures regarding preoperative proximal and distal deep vein thrombosis (DVT).	The creation of nomograms to forecast the risk of lower extremity DVT at the proximal and distal preoperative stages in elderly patients with hip fractures. Clinicians should step in and treat high-risk patients as soon as possible before surgery, according to this model's assessment.
[7]. Hingorani et al., 2007	New York	Application of Duplex Arteriography in Lower Extremity Revascularization.	For patients in need of primary or secondary lower extremity revascularization, high-quality arterial ultrasonography done by a highly qualified and experienced vascular technologist may be a viable option to traditional arteriography.
[8]. Zhang et al., 2020	China	To evaluate the stability of deep vein thrombosis (DVT) in the lower limbs using Doppler ultrasonography.	An accurate analysis of the stability of DVT in the lower extremities may be possible with Doppler ultrasonography. Reducing DVT in the lower extremities requires related measures that target risk factors.
[9]. Roberts et al., 2020	Australia	To assess the precision of compression ultrasound screening in trauma patients in the intensive care unit who are at a heightened risk of deep vein thrombosis.	When screening for proximal lower extremity deep vein thrombosis in trauma patients in the intensive care unit who are at high risk for DVT, compression ultrasonography conducted by an intensive care physician and duplex ultrasound scans show a significant degree of agreement.
[10]. Singh et al., 2022	India	To evaluate the location, severity, and stage of lower limb deep vein thrombosis in patients with and without diabetes by analyzing and interpreting the color Doppler results.	Patients with diabetes and those without diabetes have different incidences of deep vein thrombosis. Thrombus showed that diabetics had a higher incidence of involvement in lower limb veins than non-diabetics.
[11]. Chung et al., 2015	Taiwan	To assess the impact of diabetes on the likelihood of pulmonary embolism and deep vein thrombosis in a population-based cohort research conducted over the whole country of Taiwan.	According to the long-term countrywide cohort research, those with type 2 diabetes had higher odds of getting VTE than people in general.
[12]. Piazza et al., 2012	Boston	To evaluate the prevention, treatment, and results of venous thromboembolism in individuals with and without a history of diabetes.	After being diagnosed with venous thromboembolism, patients with a clinical diagnosis of diabetes were more likely to experience a complex clinical course.
[13]. Al-Thani et al., 2016	Qatar	Utilizing Doppler ultrasonography to assess clinical presentation, management, and outcomes of deep vein thrombosis.	A certain amount of gender variation in clinical presentation. However, among patients with DVT undergoing follow-up, age—rather than gender—is a significant predictor of mortality. In addition, our patients have high PE and death rates, which are in line with global statistics. Notably, depending on the risk assessment, the clinical pretest probability assessment and customized prophylaxis for inpatients and outpatients must be included.
[14]. Baxter et al., 1990	Scotland	To diagnose lower limb thrombosis by contrasting color Doppler with contrast venography.	Early experience indicates that Color Doppler may be helpful in the identification of calf thrombosis, and it has potential in the assessment of proximal calf vein patency. However, further clinical studies are required for further evaluation.

[15]. Dautat et al., 1997	France	The use of ultrasound to diagnose acute lower limb deep vein thrombosis.	Color or duplex With its exceptionally high sensitivity and specificity, Doppler ultrasound of the lower limb deep veins is unquestionably the method of choice.
[16]. Gornik et al., 2014	Ohio	Diagnosis of lower-extremity deep vein thrombosis using duplex ultrasound.	The existence of collateral circulation, venous compressibility, vein lumen size, vein wall appearance, thrombus appearance on B-mode imaging, and venous valve performance are factors that determine the acuity of a deep vein thrombosis.
[17]. de Athayde Soares et al., 2020	Brazil	Rate of Recanalization in deep venous thrombotic patients treated by rivaroxaban in aspects of ultrasound.	At six and twelve months, oral rivaroxaban showed an acceptable overall vein recanalization rate. The lack of popliteal vein reflux, the absence of residual thrombi in the veins, and the length of the femoropopliteal clot were the variables linked to greater overall recanalization rates.
[18]. Elias et al., 2004	France	To evaluate the diagnostic precision of a whole lower limb US that looks at the veins in both the proximal and distal directions.	Compared to restricted US, whole venous US is somewhat less specific but more sensitive and better able to rule out PE. Large-scale outcome studies are required to assess its use in PE diagnosis techniques.
[19]. Jude et al., 2010	Greece	Examine the peripheral artery disease in individuals with diabetes by ultrasound.	PAD is more common in DM patients. In diabetes mellitus (DM), PAD manifests sooner, advances faster, and is typically asymptomatic; nonetheless, overall and postoperative death rates are similarly elevated in this population.
[20]. Sosthène et al., 2020	Republic of the Congo	To evaluate upper and lower deep venous thrombosis by duplex ultrasound.	In the early stages of DVT diagnosis, duplex USG is the imaging modality of choice. It is available, non-invasive, and radiation-free; nonetheless, the results of this inquiry are operator dependent. DVT can be symptomatic or asymptomatic in patients. Compression ultrasound screening is beneficial in people who are at high risk for the condition.

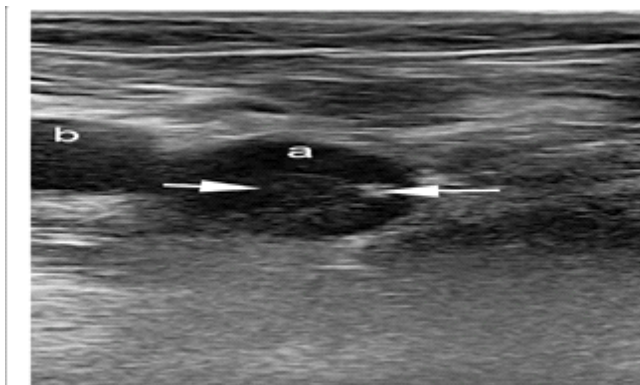


Figure 1 : A person with compression ultrasound confirmed DVT by color Doppler ultrasound [9]

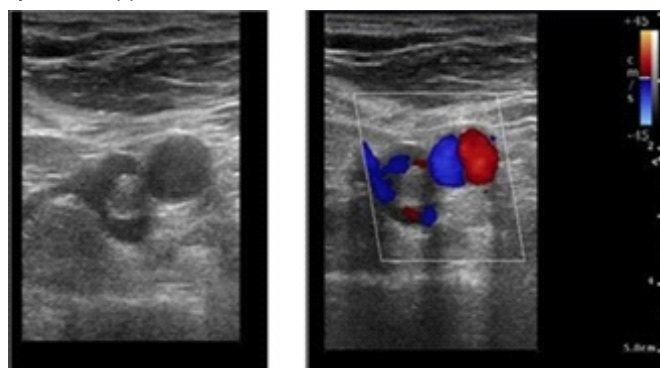


Figure 2 : Color Doppler mode shows along with a normal common femoral artery, diabetes patients have partial, chronic thrombosis of the common femoral vein (CFV) [10]

DISCUSSION

There is now a global diabetes epidemic. The prevalence of adult diabetes worldwide was estimated to be 6.4% in 2010, impacting 285 million individuals. By 2030, that number is expected to rise to 7.7%, affecting 439 million adults. Taiwan had an increase in the overall number of diabetics by more than 70% and in the standardized prevalence rate by 35% between 2000 and 2009, both of which were in line with the worldwide trend for the disease. The majority of research has concentrated on the consequences of diabetes because they lead to increased disability, shorter life expectancies, significant health costs for societies globally, and conditions like diabetic neuropathy, amputations, peripheral vascular disease, cerebrovascular accidents (CVA), diabetic neuropathy, renal failure, and blindness. Blood clots in the deep veins, and these thrombi usually originate in the legs [11]. After multivariable correction, patients with diabetes who later experienced venous thromboembolism has a 74% higher chance of developing recurrent DVT after the initial diagnosis. Following the original incident is treated, a continuously higher risk of recurrent venous thromboembolism remains

following therapy for various medical comorbidities. However, only diabetes is a significant independent predictor of recurrent DVT in multivariable regression analysis that included several of these concomitant conditions [12]. Venous ultrasonography is currently the recommended diagnostic method for a conclusive DVT diagnosis. It is a very sensitive noninvasive diagnostic technique for DVT diagnosis. Doppler ultrasonography might be utilized more precisely in conjunction with compression to identify and validate a vessel's compressibility. According to a study, Doppler ultrasonography has a 97% sensitivity for diagnosing DVT in the veins of the calf. Every patient having a clinical suspicion of having DVT is reliably identified with the disease using duplex ultrasonography [13]. With the patient in a supine posture and the leg slightly externally rotated, a 5 MHz probe is used to do color Doppler scanning. In both a transverse and longitudinal axis, the common and superficial femoral veins are visible all the way down to the adductor canal. Visualization of the saphenofemoral junction was prevalent. Patency of the popliteal and proximal calf veins is evaluated when the patient is in a lateral decubitus posture with the knee flexed to a degree of around thirty degrees. The distal calf vein compression helps to better view the tibioperoneal trunk on a longitudinal axis. Compressibility, intraluminal echogenicity, and venous flow pattern are evaluated for every venous segment [14]. The main characteristics of DVT are the absence of spontaneous blood flow, the presence of echogenic intraluminal material, and vein incompressibility. Other minor characteristics include an enlarged vein diameter, immobility of the venous wall and valve, echogenicity of the spontaneous blood flow both upstream and downstream, and an enlarged collateral vein with increased flow. Deep vein thrombosis (DVT) is vein incompressibility, which occurs when the vein can't be crushed by medium pressure using an ultrasonic transducer due to the presence of thrombi. The principal, direct symptom of thrombus echogenicity is dependent upon the B-mode system's dynamic range being properly calibrated and contrast resolution being properly maintained. It is advised to precisely control the gain during the contralateral side scan in order to display a noise-free luminosity at the maximum level [15]. The most accurate way to determine whether thrombus is present in a vein is to observe a decrease in compressibility [16]. The prognostic parameters pertaining to the outcomes of DVT are significantly influenced by the ultrasonography elements of the disease's progression. Post-thrombotic syndrome was predicted by ultrasonographic data obtained either during or after therapy for DVT in legs [17]. Therefore, venous imaging is crucial for real-time color

Doppler as well venous hemodynamics, and the depth of the vascular structures determines which probe to use [18]. However, there are more therapy options now that the mechanics of atherosclerosis are well understood. Altering one's lifestyle and successfully controlling known risk factors, such as hypertension, dyslipidemia, & hyperglycemia, might slow the disease's course and lower the risk of heart disease [19]. Sonographic results often indicate either acute or chronic DVT. When DVT is persistent, the intraluminal blood clot is hyperechoic with peripheral revascularization on color Doppler imaging, as opposed to hypoechoic or anechoic in acute DVT [20].

CONCLUSIONS

Deep vein thrombosis occurs at varying rates in people with diabetes. However, the outcome is not statistically significant. Diabetic patients were more likely than non-diabetics to have common femoral vein, femoral vein, and popliteal vein involvement, according to the anatomic localization of the thrombus. Symptoms such as discomfort were substantially more prevalent in non-diabetics than in diabetics. Doppler USG is a safe, non-invasive, and quick way to identify deep venous thrombus. As a result, early identification of DVT in clinically suspected individuals is essential.

Authors Contribution

Conceptualization: MAR

Writing-review and editing: BAK, MAA, LA, AA, SF, AR

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

All authors have read and agreed to the published version of the manuscript.

REFERENCES

- [1] Ballotta E, Toniato A, Piatto G, Mazzalai F, Da Giau G. Lower extremity arterial reconstruction for critical limb ischemia in diabetes. *Journal of Vascular Surgery*. 2014 Mar; 59(3): 708-19. doi: 10.1016/j.jvs.2013.08.103.
- [2] Aquila AM. Deep venous thrombosis. *Journal of Cardiovascular Nursing*. 2001 Jul; 15(4): 25-44. doi: 10.1097/00005082-200107000-00004.
- [3] Kremers BM, Birocchi S, Van Oerle R, Zeerleder S, Spronk HM, Mees BM, et al. Searching for a common thrombo-inflammatory basis in patients with deep vein thrombosis or peripheral artery disease. *Frontiers in Cardiovascular Medicine*. 2019 Apr; 6: 33. doi: 10.3389/fcvm.2019.00033.

- [4] Hur KY, Jun JE, Choi YJ, Lee YH, Kim DJ, Park SW, et al. Color doppler ultrasonography is a useful tool for diagnosis of peripheral artery disease in type 2 diabetes mellitus patients with ankle-brachial index 0.91 to 1.40. *Diabetes & Metabolism Journal*. 2018 Feb; 42(1): 63-73. doi: 10.4093/dmj.2018.42.1.63.
- [5] Lewis BD, James EM, Welch TJ, Joyce JW, Hallett JW, Weaver AL. Diagnosis of acute deep venous thrombosis of the lower extremities: prospective evaluation of color Doppler flow imaging versus venography. *Radiology*. 1994 Sep; 192(3): 651-5. doi: 10.1148/radiology.192.3.8058929.
- [6] Yao W, Tang WY, Wang W, Lv QM, Ding WB. Development and validation of preoperative proximal and distal lower limb deep vein thrombosis nomograms in geriatric hip fracture patients. *European Review for Medical & Pharmacological Sciences*. 2023 Nov; 27(21): 10269-83. doi: 10.26355/eurrev_202311_34303.
- [7] Hingorani AP, Ascher E, Marks N. Duplex arteriography for lower extremity revascularization. *Perspectives in Vascular Surgery and Endovascular Therapy*. 2007 Mar; 19(1): 6-20. doi: 10.1177/1531003506298080.
- [8] Zhang S, Chu W, Wang H, Liang Y, Fan Y, Liu H, et al. Evaluation of stability of deep venous thrombosis of the lower extremities using Doppler ultrasound. *Journal of International Medical Research*. 2020 Aug; 48(8): 0300060520942098. doi: 10.1177/0300060520942098.
- [9] Roberts L, Rozen T, Murphy D, Lawler A, Fitzgerald M, Gibbs H, et al. A preliminary study of intensivist-performed DVT ultrasound screening in trauma ICU patients (APSIT Study). *Annals of Intensive Care*. 2020 Dec; 10: 1-9. doi: 10.1186/s13613-020-00739-8.
- [10] Singh B, Gara H, Singh M, Raj G, Marak J. Comparative Colour Doppler study of lower limb deep venous thrombosis in diabetic and non-diabetic patients with review of current knowledge. *International Journal of Medical Reviews and Case Reports*. 2022 Aug; 6(10): 22. doi: 10.5455/IJMRCR.172-1645679600
- [11] Chung WS, Lin CL, Kao CH. Diabetes increases the risk of deep-vein thrombosis and pulmonary embolism. *Thrombosis and Haemostasis*. 2015 Oct; 114(10): 812-8. doi: 10.1160/TH14-10-0868.
- [12] Piazza G, Goldhaber SZ, Kroll A, Goldberg RJ, Emery C, Spencer FA. Venous thromboembolism in patients with diabetes mellitus. *The American Journal of Medicine*. 2012 Jul; 125(7): 709-16. doi: 10.1016/j.amjmed.2011.12.004.
- [13] Al-Thani H, El-Menyar A, Asim M, Kiliyanni AS. Clinical presentation, management, and outcomes of deep vein thrombosis based on Doppler ultrasonography examination. *Angiology*. 2016 Jul; 67(6): 587-95. doi: 10.1177/0003319715604265.
- [14] Baxter GM, McKechnie S, Duffy P. Colour Doppler ultrasound in deep venous thrombosis: a comparison with venography. *Clinical Radiology*. 1990 Jul; 42(1): 32-6. doi: 10.1016/S0009-9260(05)81618-6.
- [15] Dauzat M, Laroche JP, Deklunder G, Ayoub J, Quéré I, Lopez FM, et al. Diagnosis of acute lower limb deep venous thrombosis with ultrasound: trends and controversies. *Journal of Clinical Ultrasound*. 1997 Sep; 25(7): 343-58. doi: 10.1002/(SICI)1097-0096(199709)25:7<343::AID-JCU1>3.3.CO;2-8.
- [16] Gornik HL and Sharma AM. Duplex ultrasound in the diagnosis of lower-extremity deep venous thrombosis. *Circulation*. 2014 Feb; 129(8): 917-21. doi: 10.1161/CIRCULATIONAHA.113.002966.
- [17] de Athayde Soares R, Matielo MF, Neto FC, Almeida RD, Sacilotto R. Ultrasound aspects and recanalization rates in patients with lower-limb deep venous thrombosis treated with rivaroxaban. *Annals of Vascular Surgery*. 2020 Aug; 67: 293-9. doi: 10.1016/j.avsg.2020.01.017.
- [18] Elias A, Colombier D, Victor G, Elias M, Arnaud C, Juchet H, et al. Diagnostic performance of complete lower limb venous ultrasound in patients with clinically suspected acute pulmonary embolism. *Thrombosis and Haemostasis*. 2004 Jan; 91(01): 187-95. doi: 10.1160/TH03-05-0278.
- [19] Jude EB, Eleftheriadou I, Tentolouris N. Peripheral arterial disease in diabetes—a review. *Diabetic Medicine*. 2010 Jan; 27(1): 4-14. doi: 10.1111/j.1464-5491.2009.02866.x.
- [20] Sosthène TV, Serge KK, Medard KK, Simplicite KV, John MK, Albin SS. Duplex ultrasound in upper and lower limb deep venous thrombosis. *Annals of Circulation*. 2020 Feb; 5(1): 001-7. doi: 10.17352/ac.000015.