Assessment of Deep Vein Thrombosis Using Multidetector Computed Tomography After Arthroplasty: A Retrospective Comparative Study with Doppler Sonography

Sami Smerat, Azzam Alarab, Maram Ghassan Sada, Issa Al Hroush, Marah Abu Muhsen, Murad Abu Samra, Moath Al-Makhamreh, Sojood Mansour, Mohammad Almashny, Hasan Naji and Mohammed Hjouj

ABSTRACT

**Purpose:** The purpose of this retrospective study was to compare the ability of indirect 128-row multidetector CT (MDCT) venography and doppler sonography to detect deep vein thrombosis (DVT) after knee or hip arthroplasty.

**Methods and Materials:** Replacement surgery was performed on a total of ten hip and sixty-eight knee joints in 52 patients. The evaluation of the presence of DVT is degraded by the beam hardening artifact; therefore, Axial CT images could not be used to assess DVT. The beam hardening artifact's z-axis length was measured. Deep vein thrombosis was studied to see how common it is and where it occurs. The CT venograms' diagnostic performance was assessed and compared to that of the gold standard diagnostic reference for DVT: doppler sonography.

**Result:** The beam hardening artifact had a z-axis length of 6.0 (mean standard deviation). Doppler sonography is a technique that allows you to see what's going on inside your body. In 30/52 individuals, DVT was found in the calf veins (58 percent of total population). The binary scale diagnostic test revealed that CT venography and doppler sonography had sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 93.33 percent, 90.91 percent, 90.91 percent, and 92.31 percent, respectively.

**Conclusion:** For the aim of evaluating post-arthroplasty patients, CT venography can be utilized as a substitute for doppler sonography.

**Keywords:** Arthroplasty, Doppler Sonography, DVT, MDCT.

I. INTRODUCTION

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are both common surgical procedures. Such treatments expose patients to a variety of dangers, including the development of venous thromboembolism (which has an incidence of up to 84 percent) [1], [2], blood clots, and deep vein thrombosis (DVT). Complications such as post-coagulation syndrome, recurrent DVT, and pulmonary hypertension are also possible [3], [4]. renders early detection of DVT a crucial step in the management of post-arthroplasty patients.

Deep Vein Thrombosis is most commonly detected
through CT venography [5], doppler sonography [6], and MR death rate), while total infections reached 53,939 (14.1% venography [7]. Doppler sonography is the gold standard for detecting DVT due to the fact that is noninvasive, has no side effects, poses no risk to the patient, and cost-effective [8]. To our knowledge, Because of the beam hardening artifact, CT is not used to identify DVT following THA or knee arthroplasty. which appears as a result of the dense material used for the joint replacements. Despite its lack of use, CT has great potential in detecting DVT. CT has revolutionized decision making especially regarding surgical intervention [9], [10]. CT improved surgical techniques, treatment planning, and diagnosis of cancereal tumors. Additionally, it improved treatment after injury and major trauma, stroke detection, and treatment of heart disease [10], [11]. CT had a major impact on manifestations of CXR and chest CT scans in order to familiarize radiologists and radiologic surgery as it reduced the need for surgery from 13% to 5% [12]. Technological advances that increased imaging accuracy, decreased scanning time, and increased CT applications have made it an increasingly attractive imaging modality [13], [14]. Computed tomographic angiography (CTA) can provide a 3D image of the lower limb blood vessels. CTA can easily reveal stenosis and any vascular abnormality [15].

Modern sonography has a wide range of applications for example, it is used in obstetrics to noninvasively monitor fetal development, in oncology to visualize tumors and their response to treatment, and in cardiology. Ultrasound is a very safe and effective modality used to screen diseases [16]. Ultrasound (US) has for some time been perceived as an amazingly valuable demonstrative imaging methodology on account of its continuous capacity, noninvasiveness, transportability, and moderately minimal expense. In addition, the risks connected with the injection of intravenous contrast material or the possible hazards of ionizing radiation are not present when using ultrasound imaging. As a result, several medical and surgical subspecialties are increasingly adopting ultrasound as a supplement or extension of the physical examination.

Despite the decreasing features of the beam hardening artifact, [17] found that CT venography had a similar ability to detect DVT as Doppler sonography. As a result, computed tomography (CT) venography can be used as an alternate approach of evaluating post-arthroplasty patients. The purpose of this study was to assess the effectiveness of MDCT venography against Doppler sonography in detecting DVT following THA or TKA.

II. MATERIAL AND METHODS

A. Study Area/Setting

The study population included all patients who went through all-out knee substitution or complete hip substitution. Evaluated in terms of structure (patient information, history, indication, previous study, Z-axis and quality) after complete hip or knee replacement to detect deep vein thrombosis. The size of the sample consisted of 52 patients. Patient were conveniently selected from department. The researcher will use different tools to collect information’s in his research including, personal data (age, gender) and medical history (indication, previous study, CT and ultrasound exam), z-axis length, quality (Good, Sufficient, Insufficient).

B. Ethical Considerations

The Palestinian Ministry of Health's Research Ethics Committee approved the study (MoH).

III. RESULT

This study included a total of 52 patients. 21 patients (40%) were males, and 31 patients (60%) were females. All the participated patients were above 60 years old. The average age of the participants was 70.7± 3.9 (Mean ±standard deviation). The average age for men was 71.7±3.4, while among women the average age was 70±4.2. All of them were examined by CT venography and Doppler sonography after the surgery. With respect to the length of Hardening of the package tool that led to the deterioration of the quality of the image along the z axis (mean ± standard deviation) was 4.6 ± 1.0 cm. The table below represents the descriptive statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>52</td>
<td>60</td>
<td>78</td>
<td>70.69</td>
<td>3.983</td>
</tr>
<tr>
<td>Z-Axis Length</td>
<td>52</td>
<td>3.0</td>
<td>6.0</td>
<td>4.606</td>
<td>1.0114</td>
</tr>
</tbody>
</table>

Out of the total 52 patients, 42 patients underwent Total Knee Arthroplasty (TKA). In which,17 out of the 42 patients had unilateral TKA, and 25 had bilateral TKA. On the other hand, 9 patients underwent Total Hip Arthroplasty (THA). All of them had unilateral THA. One patient was performed both THA and TKA unilaterally during one operation. After surgery, noninvasive color duplex Doppler ultrasound flow scanning and indirect 128-row multidetector row CT venography was used to analyze 10 hips and 68 knees.

Doppler sonography revealed DVT in the calf veins in 30 (58%) of the 52 individuals who participated in this investigation. Location and Incidence of Deep Vein Thrombosis as Detected by Doppler Sonography are depicted in the Table II.

At the gender level, the data analysis revealed that 81% of the males were detected with DVT after TKA or THA, while only 42% the females were detected with DVT after the surgery. This means that males are susceptible to DVT after TKA or THA more than females. However, this result wasn’t analyzed statistically.

In four individuals, there were discrepancies between CT venograms and Doppler sonography. In two of the patients, Despite the existence of DVT as revealed by Doppler sonography, CT venography failed to identify it at first. Nonetheless, in these two patients, the DVT was discovered retrospectively on CT venography. CT venography revealed a focal DVT in the leg veins in two other patients, However, repeated sonographic studies revealed no DVT in the calf veins. The diagnostic findings of MDCT venography for deep vein thrombosis following arthroplasty are compared to those of Doppler sonography in the table below.
The CT venography images' quality was solely subjectively assessed. Based on visual analysis, the image quality of the CT venograms was rated as good, sufficient, or insufficient. The term 'good' refers to the degree of venous enhancement being comparable to the nearby arterial enhancement. The term "insufficient" refers to the degree of venous enhancement being comparable to the degree of muscle enhancement in the surrounding area. The term "sufficient" refers to the degree of venous enhancement that was comparable to the arterial and muscle enhancements. The data analysis found that 50 CT images (96%) were good, whereas only 2 CT images (4%) were adequate, and none of the CT images were inadequate. The table below provides a more detailed breakdown of these findings.

The study's main aim is to see if there are any statistically significant differences in DVT detection between Doppler Sonography and CT venography in post-arthroplasty patients. The Binary-Scale Diagnostic Test and McNemar's Test were employed in this study. The researcher utilized MedCalc statistical software Version 19.1.3 to test the study's sensitivity (Se), specificity (Sp), and positive and negative predictive values (PPV and NPV). MedCalc is a biomedical-sciences-specific statistical software tool. It's a web application that displays a web interface in the foreground and performs calculations in the background using the MedCalc Windows application. In the browser, the results and graphs are shown.

Diagnostic Results of MDCT Venography for the Detection of Deep Vein Thrombosis after Arthroplasty Compared with Those from Doppler Sonography was the data utilized to run the test. The data used to run the test are listed in the table below.

The sensitivity (Se) value was 93.33 percent based on these data. This suggests that in 93.33 percent of cases, the two approaches are able to diagnose DVT in the same way. Furthermore, the value of Specificity (Sp) was 90.91 percent. This suggests that when both approaches incorrectly detect DVT, they are identical in 90.91 percent of cases. As a result, the PPV was 93.33 percent, while the NPV was 90.91 percent. As a consequence, the accuracy was 92.31%. As a result, despite the beam hardening effect, we may conclude that CT venography's diagnostic ability was comparable to that of Doppler sonography. As a result, CT venography can be used to evaluate post-arthroplasty patients as an alternate technique. The results of the Binary-Scale Diagnostic Test are shown in the table below.

The test resulted in a p value of 1.00, which is significantly higher than 0.05. As a result, we conclude that there are no statistically significant differences in diagnosing DVT in post-arthroplasty patients using Doppler Sonography and CT venography. The results are provided in the table below, as they appeared in the SPSS output.
IV. DISCUSSION

The diagnostic ability of computed tomography on DVT in the lower extremities to be comparable with Doppler sonography has developed remarkably with the development of devices and their access to the MDCT [43], [48]-[49]. These results were mainly based on optical analysis and attenuation between the muscles and the vein, as well as by measurement of the attenuation. In the beginning, the biggest indication for the exclusion of the stratified system from diagnosing deep vein thrombosis was the presence of an artificial joint that results in a radiation threat to the organ to be diagnosed. In addition, the beam hardening artifacts that develop due to the artificial joint substances strongly hampers using MDCT. However, artificial joints may directly affect the diagnosis of DVT due to their enlargement and the size that covers the veins to be diagnosed [49]. Beam-hardening artifacts were consistently seen in TKA patients in a small area (equal to or less than 6.0 cm in our study) where the prosthetic joint was visible on the axial image. The artifact involved the very long section from the femoral head to the middle femur shaft in THA patients; nonetheless, the artifact did not significantly affect image quality. The reasons for this can be deduced from the fact that the substantial length of the artifact inside the arthroplasty hip was significantly less than that inside the arthroplasty knees. First, on axial CT images, the area of the artificial joint material in the arthroplasty hip was reduced. Second, in the arthroplasty hiatus, the distance between the nearby main vein and the artificial joint material was longer. The picture quality in the arthroplasty hip and knees was unaffected by the beam hardening artifact along the very long lengths. DVT occurred exclusively in the calf veins for the majority of the participants in our study. The significance of an isolated calf vein DVT as the cause of a clinically critical pulmonary embolism or chronic decreasing extremities symptoms has been a hot topic in scientific circles [43]. According to [5] the calf vein DVT after TKA fades spontaneously with time. There was no recurrent DVT, proximal propagation, or embolism among the forty-eight patients in Wang's study. On the other hand, [50] found that a calf vein thrombosis might spread to the proximal veins; 50% of the calf clots dissolved within 4 months, while reflux developed in at least 75% of the limbs with DVT. Our research involved a total of 52 patients. Total Knee Arthroplasty was performed on 42 patients, 21 of whom were men and 31 of whom were women (TKA). 9 individuals, on the other hand, had total hip replacement surgery (THA). They all had THA on one side. THA and TKA were performed unilaterally in only one patient at a single procedure. DVT was far more common after TKA than it was after THA. These are comparable to the findings of [51].

Immobilization, soft tissue edema, and infection following joint surgery are most likely the main reasons. Discrepancies between CT venograms and Doppler sonography were found in four individuals, according to [17] despite the presence of DVT as revealed by Doppler sonography in three patients, CT venography failed to detect the DVT in the first place. However, in these three individuals, the DVT was discovered after the CT venography was completed. The CT venography of one patient revealed a worrisome localized DVT within the leg veins. On repeated sonographic scans, however, no DVT was seen inside the calf veins. Based on Doppler sonography results, CT venography has a sensitivity, specificity, positive predictive price, negative predictive price, and accuracy of 90%, 9%, 96%, 91%, and 94%, respectively, for the investigation of DVT following a necessary orthopedic arthroplasty [17]. In four of the patients in our investigation, there were discrepancies between CT venograms and Doppler sonography. Despite the existence of DVT as revealed by Doppler sonography in two cases, CT venography did not initially detect the DVT. The DVT was identified retrospectively on CT venography in these two individuals, however. Additionally, in another two patients, CT venography revealed a worrisome focal DVT in the calf veins, but further sonographic exams revealed no DVT in the calf veins. For this reason, the results of a prior study by [17] were similar to ours. Due to its wide availability and patient safety, Doppler sonography has become the most popular imaging technique for identifying DVT after joint arthroplasty [52]-[54]. Although venography is widely regarded as the gold standard for detecting DVT, it has several drawbacks, including the difficulties of repeat examinations, radiation exposure, contrast agent allergy, and the possibility of inducing DVT. Ultrasoundography has become increasingly popular in recent years all around the world. While it is less successful in detecting DVT below the knee (which isn’t a major clinical concern), it does have some advantages. These advantages include the ability to detect DVT above the knee, the convenience of examination at the bedside, which allows for repeat exams, and the lack of radiation exposure and allergic reaction. In addition to having a greater sensitivity (88–100%) and specificity (96–100%) than venography [47], [55], [56]. Despite beam hardening artifact, the diagnostic ability of CT venography was comparable to that of Doppler sonography in our investigation. As a result, CT venography is a viable option for evaluating post-arthroplasty patients.

REFERENCES


ultrasound and the importance of the experience of the technician. JBSJ. 1996; 78(9): 1359-65.


S. Smerat was born in the city of Hebron, Palestine. He received his B.A. degree in Radiography from Palestine Ahliya university in Bethlehem, Palestine in 2016. Moreover, he was a Research assistant (RA) and Lecturer in Palestine Ahliya university for four years. He has worked as a Radiologic technologist in various private clinics and is currently working at Istishari Arab Hospital. He is a proactive researcher and has published research regarding diagnostic imaging and physiotherapy. His areas of interest are physiotherapy and ultrasound.

A. Alarab was born in the city of Hebron in Palestine. He earned a B.A. degree in Physical therapy from the Arab American University in 2008. Afterwards, he received his M.A. degree in Physiotherapy and rehabilitation from Dokuz Eylul university in Turkey in the year 2013. Moreover, he received his PhD in Orthopedic rehabilitation from Pamukkale university in Turkey. He has published many articles, one of which evaluates the therapeutic techniques for musculoskeletal pain.

M. Al-Makkamreh was born in Hebron, Palestine. He earned his B.A. degree in Radiography from Al-Quds university in 2011. Afterwards, he received a M.A. degree from Al-Quds university in Functional imaging in the year 2020. He previously worked as a Radiologic technologist (R.T.) at Al-Ahli Hospital in Hebron. Currently, he works at Public Yatta Hospital as a Radiologic Technologist (R.T.). He published an article regarding IV contrast timing in abdominal CT imaging.

M. Mohammad Abu Samra was born in the city of Hebron in Palestine. He received his doctor of medicine degree (M.D.) from Al-Quds University in 2007. Moreover, he earned his specialty in Diagnostic radiology from ACGME-I program in the American University of Beirut in Lebanon in 2016. Afterwards, he specialized in Nuclear oncology from the Memorial Sloan Kettering Cancer Center in New York, USA in 2019 and in 2020 he specialized in MRI Oncologic Imaging. Currently, he is working as an Assistant professor in Icahn School of Medicine at Mount Sinai, New York, USA. Previously, he worked as a teaching assistant in the anatomy department at Al-Quds University in 2011. He earned extensive working and training experience as a radiologist and specialized nuclear oncologist in multiple clinics and hospitals. He has published many articles involving breast cancer imaging through PET/CT, interventional imaging, and radiation protection involving nuclear medicine.

A. Alarab was born in the city of Hebron in Palestine. He earned a B.A. degree in Physical therapy from the Arab American University in 2008. Afterwards, he received his M.A. degree in Physiotherapy and rehabilitation from Dokuz Eylul university in Turkey in the year 2013. Moreover, he received his PhD in Orthopedic rehabilitation from Pamukkale university in Turkey. He has published many articles, one of which evaluates the therapeutic techniques for musculoskeletal pain.

M. Ghassan Sada was born in Chicago, Illinois in the United States of America. She is currently earning her B.A. degree in Radiography from Al-Quds University. She participated in an internship job as a Radiologic technologist (R.T.) at Al-Lijan Imaging Center in Hebron. She previously conducted unpublished research involving the risk perception of medical imaging. She has published an article regarding the severe chest imaging findings of Coronavirus disease in Palestine. Her research ambitions include hybrid imaging, cardiac imaging, and artificial intelligence (AI).

I. S. Al Hroush was born in Hebron, Palestine. He earned a B.A. degree in Radiography from the Arab American university in the year 2013. He previously worked as a Radiologic technologist (R.T.) at the Palestinian Red Crescent Society. He was Chief technologist and training coordinator at An-Najah University Hospital. He is currently chief radiologic technologist at the Istishari Arab Hospital where he is specialized in and oversees CT and MRI imaging sections.

M. Abu Muhsen was born in the city of Nablus in Palestine. She acquired her B.A. degree in radiologic technology from the Arab American University in the year 2015. Since then, she has been proactive in the field of radiography: she earned Philips Healthcare certifications for intensive training in MRI and CT in the year of 2016. She currently works in the radiology department of Istishari Arab Hospital as a radiologic technologist and is a member of the quality control (QC) staff.

S. Mansour Was born in Jericho, Palestine. She earned her B.A. degree in Medical Imaging from Al-Quds University in 2021. She ranked 1st in the health professions college on her graduation year 2020/2021. She was the vice president of Al-Quds UniversityHealth Professions Scientific Research Club in 2019. She participated at the Scientific Research Basics and Skills Summit organized by the Deanship of Scientific Research and Postgraduate Studies at Al-Quds University. After her graduation, she has been volunteering as a radiographer at Palestine Red Crescent Society al- Bireh Branch and Dunya Women’s Cancer Centre in the city of Ramallah. She is currently a radiologic technologist at the Palestinian ministry of health. She has published an article regarding the severe chest imaging findings of Coronavirus disease in Palestine. Her research ambitions include but are not limited to: Breast cancer imaging, Neuroimaging, Interventional Imaging, and Radiotherapy.

Mohammed Hijouj was born in Hebron, Palestine. He received a B.A. degree in Radiography from Al-Quds University in the year 2002. Later in 2004 he earned his M.A. degree in Medical imaging from the University of Leeds in the UK. Additionally, he earned his Ph.D. in Biomedical engineering and medical imaging from The Hebrew university in Jerusalem in 2013. He is currently a professor in the medical imaging department of Al-Quds university; moreover, he was previously the head of the department. He is an academic and PACS administrator at Al-Makassed Hospital in Jerusalem. He has participated in a plethora of training programs involving MRI safety, radiation safety, and ultrasonography (to mention a few). Furthermore, he is an active member of international and local conferences and workshops that focus on scientific research. Throughout his lengthy professional experience as M.A. coordinator and researcher, he has published articles involving MR Imaging, hepatocellular carcinoma, image-guided therapy, etc. His research interests aim at developing affordable medical diagnosis and treatment technologies to reduce medical care cost in remote and impoverished parts of the world including: Cancer Diagnosis and Treatment, Electroporation (Reversible: ECT & EGT, and Irreversible), medical imaging technology, Functional Imaging mainly (MRE, EEG, MEG, NM), and osteoporosis. He is a member of the International Society for Electroporation-Based Technologies and Treatments (ISEBTT) and The European Society of Radiology (ESR).

DOI: http://dx.doi.org/10.24018/ejmed.2022.4.6.1150 

Vol 4 | Issue 6 | November 2022
H. Naji was born in Nablus, Palestine. He earned a B.A. degree in accounting from the national al Najah university. He earned master degree about accounting and auditing from Arab American university in the year 2022. He is currently patient accountant at the Istishari Arab Hospital over three years ago.