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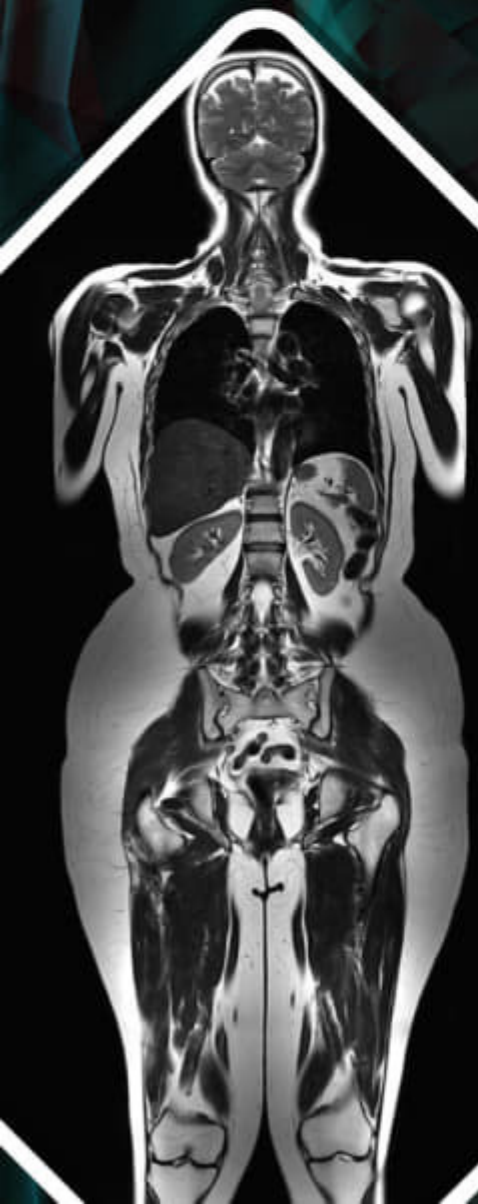

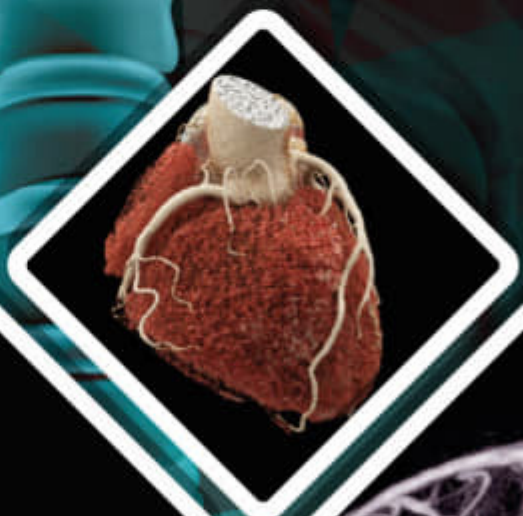

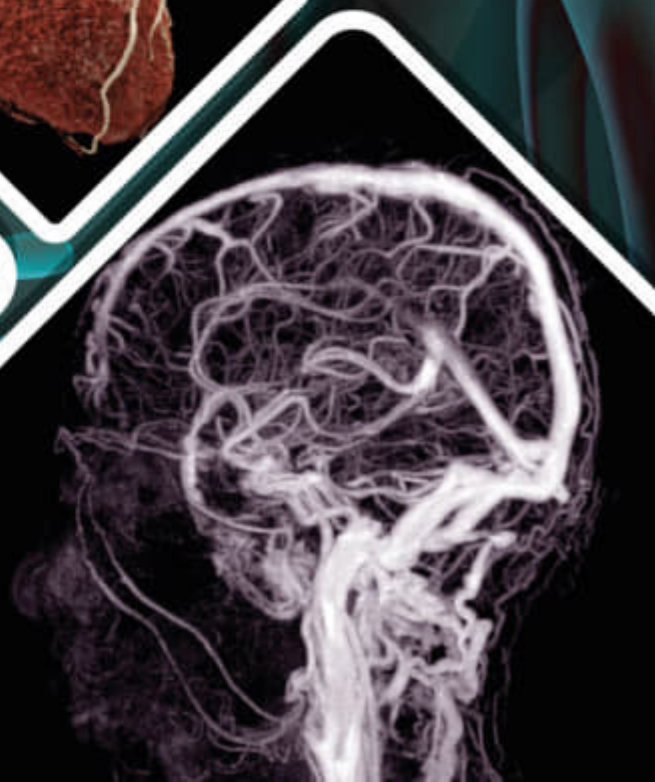

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Journal of Radiology in Medicine

Editorial

We had a successful year with up-to-date studies in the field of radiology in the first anniversary of the "*Journal of Radiology in Medicine*". Radiology is one of the most dynamic and rapidly developing branches of modern medicine. This branch of science, which plays a vital role in making a diagnosis and guiding the treatment processes, is also constantly enriched with academic and practical information.

Our journal includes original research articles, meta-analyses, technical reports and studies on innovative imaging techniques. The published articles appeal not only to academics but also to all health professionals interested in radiology. At the same time, they will inspire students and researchers for new studies.

Journal of Radiology in Medicine aims to be a bridge that brings together scientists and health professionals, playing an important role in the development of radiology informatics. Sharing developing medical technologies and new treatment methods will be one of the important publications that bring scientific cooperation to the scientific world.

Best regards,

Assoc. Prof. Adnan Özdemir
Assoc. Prof. Mehmet Hamdi Şahan
Editors-in-Chief

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ORIGINAL ARTICLES

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Original Article

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Comparison of percutaneous liver aspiration biopsy and tru-cut biopsy results

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ABSTRACT

Aims: The aim of this study was to compare the diagnostic rates, complications and histopathologic diagnoses of aspiration biopsy and tru-cut biopsy procedures in liver parenchyma and to reveal the differences between the technical methods.

Methods: Patients who underwent liver parenchymal biopsy in our hospital were identified. While tru-cut biopsy needle was used in the radiology department, aspiration biopsy needle was used in the gastroenterology department. Patients who underwent parenchymal biopsy were included in the study, while lesion biopsies were excluded. Type of biopsy needle, biopsy size, number of samples taken and number of portal areas, size of biopsy material, pathologic diagnosis and post-biopsy complications were evaluated in all patients.

Results: Of the 113 patients who underwent liver biopsy, tru-cut biopsy needle was used in 46 patients and aspiration biopsy needle was used in 67 patients. Pathologic diagnosis was made in 111 of 113 patients who underwent liver biopsy. The diagnosis rate was 98.2%. There was no statistically significant difference in pathological diagnosis, Ishak fibrosis score and complication development between tru-cut and aspiration biopsies. The number of specimens taken and biopsy sizes was significantly higher in aspiration biopsy ($p<0.001$). The number of portal areas were statistically significantly larger in aspiration biopsy compared to tru-cut biopsy ($p=0.005$).

Conclusion: Percutaneous aspiration and tru-cut biopsies are reliable diagnostic methods with high diagnostic rates and low complication rates. The fact that biopsy is performed by experienced hands, under US guidance, and the number of biopsies is limited reduces the development of complications.

Keywords: Liver, biopsy, needle, aspiration, tru-cut

INTRODUCTION

Liver biopsy is mostly used for the diagnosis and staging of chronic liver diseases and histopathologic examination of response to treatment. Apart from these, there are other reasons such as elevated liver function tests, diagnosis of lesions in the liver, evaluation of liver involvement in systemic diseases, evaluation of the donor in liver transplantation, differentiation between simple fatty liver disease and steatohepatitis.[1]

There are different biopsy techniques for obtaining liver tissue including percutaneous, transjugular, laparoscopic and intraoperative. Percutaneous biopsies can also be performed under imaging guidance. Ultrasonography (USG), computed tomography (CT) or magnetic resonance imaging (MRI) can be used as imaging modalities.[2,3]

In percutaneous liver biopsy, aspiration, cutting and spring cutting needles are used for this purpose.[4]

The aim of our study was to compare the diagnostic rates, complications and histopathologic diagnoses of aspiration biopsy and tru-cut biopsy procedures in liver parenchyma and to reveal the differences between the technical methods.

METHODS

This study was conducted in Kırıkkale University Faculty of Medicine Hospital according to the principles of the Declaration of Helsinki after Kırıkkale University Ethics Committee approval (Date: 26.06.2024, Decision No: 2024.06.2022). Patients who underwent liver needle biopsy in radiology and gastroenterology departments between January 2018 and January 2023 were identified retrospectively. Demographic information of the patients was obtained by scanning the files in the hospital registration system.

Patients who underwent parenchymal biopsy were included in the study. While tru-cut biopsy needle was used in the radiology department, aspiration biopsy needle was used in the gastroenterology department.

These patients were not included in the study because of the anatomical location of the focal lesion and the increased risks depending on the localization.

Type of biopsy needle, biopsy size, number of samples taken and number of portal areas, size of biopsy material, pathologic diagnosis and post-biopsy complications were evaluated in all patients.

Biopsy Procedure

Anticoagulant drugs that would affect bleeding were discontinued at least 5 days before liver biopsy. Complete blood count activated partial thromboplastin time and prothrombin time/INR were obtained from all patients before the procedure. The procedures were performed after at least 6 hours of fasting. All patients were informed in detail about the procedure and its complications by the attending physician and written informed consent was obtained.

Tru-cut biopsies were performed under the guidance of a convex probe on a USG device. A sterile sheath was put on the probe before the procedure. The most appropriate place for the needle to enter was determined by USG. After marking with US, local anesthesia (1% lidocaine) was applied under the skin and then a small incision was made at the needle entry site. The patient was made to hold his/her breath, and a biopsy sample was obtained by entering the biopsy needle from the edge of the probe with a free hand technique (**Figure**). The biopsy material was placed in formol solution. If the material was macroscopically appropriate, the procedure was completed, otherwise the procedure was repeated. Each patient was observed for at least 6 hours after the procedure. Patients with no complications at the end of these periods were discharged.

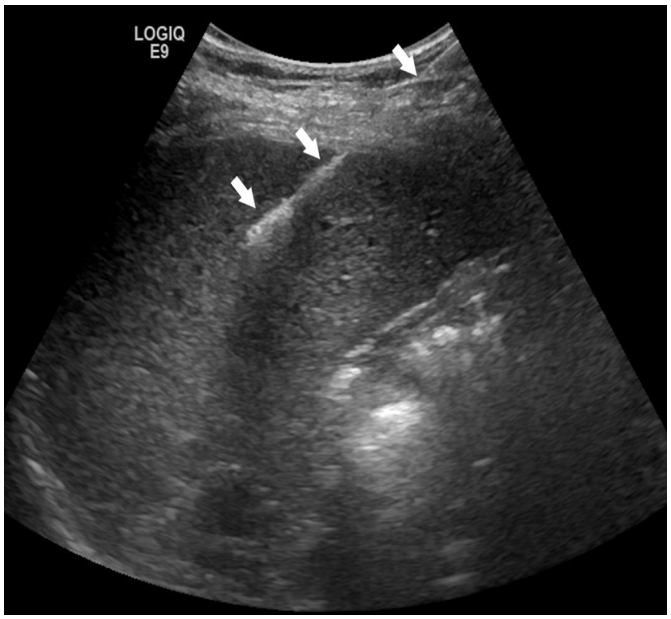

Figure. Gray scale US image of USG-guided percutaneous sharp needle biopsy. Needle tracing in the right lobe of the liver is indicated by the white arrow
USG: Ultrasonography

Evaluation

Patients were divided into two groups as aspiration and tru-cut biopsy. Complications, diagnostic rate, reasons for biopsy and presence of hepatitis were evaluated in both groups. Complications were evaluated in two groups as minor and major. Transient discomfort localized to the biopsy area, pain with or without anelgesia, vasovagal symptoms, vomiting were considered minor complications. Bleeding, infection, visceral perforation, hemothorax, pneumothorax, subcutaneous emphysema, anesthetic reaction, needle breakage were considered major complications.[5]

Necroinflammatory activity and fibrosis were evaluated with the Ishak scoring system. Patients were divided into three groups according to the Ishak fibrosis score: mild fibrosis (F≤2), moderate fibrosis (F3-4), and advanced fibrosis (cirrhosis) (F5-6).[6]

Statistical Analysis

Data were analyzed using SPSS 20.0 statistical package program (Statistical Package for the Social Sciences, version 20.0, SPPSS Inc, Chicago, IL, USA). Kolmogorov-Smirnov analysis was used to test for normal distribution. Variables were expressed as arithmetic mean±standard deviation (SD). Chi-square test was used for categorical variables and means and percentages were calculated. Student t test was used for comparison of groups. $p<0.05$ was considered significant.

RESULTS

Of the 113 patients who underwent liver biopsy, tru-cut biopsy needle was used in 46 patients and aspiration biopsy needle was used in 67 patients. Among the patients who underwent tru-cut biopsy, 31 were male and 15 were female, while among the patients who underwent aspiration biopsy, 43 were male and 24 were female. There was no statistically significant difference ($p=0.724$). Pathologic diagnosis was made in 111 of 113 patients who underwent liver biopsy. The diagnosis rate was 98.2%. There was no statistically significant difference in pathological diagnosis between tru-cut and aspiration biopsies. Also, according to the Ishak fibrosis score, there was no significant difference between trucut and aspiration biopsies (**Table 1**).

After the procedure, 110 patients did not develop any complications, while pain was observed in 3 patients. Our complication rate was calculated as 2.7%.

The number of specimens taken and biopsy sizes was significantly higher in aspiration biopsy ($p<0.001$). The number of portal areas were statistically significantly larger in aspiration biopsy compared to tru-cut biopsy ($p=0.005$). Complications, biopsy size, number of samples taken and number of portal areas in the sample in liver biopsy procedure are shown in **Table 2**.

DISCUSSION

Liver biopsy is a diagnostic tool used for the staging of chronic liver diseases, determination of treatment indications, histopathologic evaluation of treatment responses, liver dysfunctions of undetermined cause, space-occupying lesions in the liver and evaluation of liver involvement of systemic diseases.[7] Our study included patients with elevated viral liver function tests (LFTs) and patients with elevated non-viral LFTs.

There are studies on biochemical tests that are thought to indicate liver fibrosis. In the study conducted by Karlıdağ et al.[8]

Table 1. Comparison of histopathological diagnostic features and fibrosis score between groups

		Tru-cut biopsy (n=46)	Aspiration biopsy (n=67)	p values
Histopathological diagnoses n (%)	Low-scoring hepatitis	6 (13%)	0	>.05*
	Chronic active hepatitis	2 (4.3%)	0	
	Chronic hepatitis	37 (80.4%)	64 (95.5%)	
	Cirrhosis	0	2 (3%)	
Stage of fibrosis n (%)	Mild fibrosis (stage ≤2)	38 (84.4%)	43 (65.2%)	>.05*
	Moderate fibrosis (stage 3-4)	7 (15.6%)	16 (24.2%)	
	Cirrhosis (stage 5-6)	0	7 (10.6%)	

Values are expressed as number (percent). * Chi-Square analysis

Table 2. Comparison of biopsy sample characteristics and complications between groups

	Tru-cut biopsy (n=46)	Aspiration biopsy (n=67)	p values
Sample size, mm	16.91±5.32	31.40±10.51	.000*
Mean number of samples, n	1.52±0.6 (1-3)	2.57±1.6 (1-8)	.000*
Mean number of portal triads, n	6.26±2.8 (0-16)	8.03±4.3 (0-18)	.005*
Complication, n (%)	1 (2.2%)	2 (3%)	.794**

Values are expressed as number (percent) and mean±SD (range). * Chi-square analysis. **Student t test, SD: Standart deviation

it was predicted that some biochemical tests may be associated with advanced fibrosis. In the same study, it was stated that noninvasive tests may reduce the need for liver biopsy, but will not eliminate it.

The role of liver biopsy in chronic viral hepatitis is to confirm the diagnosis of chronic hepatitis, to confirm the histologic activity score (grade), to evaluate structural changes, to assess the presence of any concurrent disease, to evaluate the response to treatment before and after treatment, to detect iron accumulation, and to interpret preneoplastic changes.[9,10] Histologic grade and stage are of prognostic importance in determining the severity and progression of disease in chronic hepatitis. Grade is an indicator of inflammation and hepatocellular damage in the liver, indicating differentiation and suggesting that this damage may progress to fibrosis. Stage indicates the presence and extent of fibrosis. In our study, there was no statistical difference in Ishak fibrosis score of tru-cut and aspiration biopsies.

The choice of liver biopsy technique is based on the patient's coagulation status, the presence of ascites, whether the liver is cirrhotic or not, and the presence of space-occupying lesions in the liver.[11]

There are several approaches to obtaining liver tissue, percutaneous, transjugular, laparoscopic and intraoperative, each with its advantages and disadvantages.[11] In percutaneous liver biopsy, suction, cutting and spring-loaded cutting needles are used for this purpose.[4] In our study, we used aspiration needle and tru-cut needle.

USG-guided liver biopsy is an easy, inexpensive, non-ionizing, non-ionizing, simultaneous technique with high diagnostic value.[12,13] In our study, tru-cut biopsies were performed under USG guidance, but USG was not used in aspiration procedures.

In many previous studies, 16G cutting biopsy needles were used in focal liver masses and it was shown that there was no significant difference between 16G and 18G needles in obtaining adequate specimens.[14] In another study conducted by Arıbaş et al.[13] in recent years, it was reported that there was no significant difference between 14G, 16G and 18G needles in obtaining adequate specimens from focal liver mass biopsies performed with cutting needles. In the tru-cut biopsy performed in our study, we used 18G diameter automatic cutting needles because it was more comfortable for all patients.

The size of the biopsy sample varies according to the diameter of the needle and the technique. Generally, the volume and length of the biopsy taken with aspiration and cutting needles are the same.[9,15] However, there are also studies that suggest that the material taken with cutting needles is larger compared to aspiration needles.[16,17] This larger material allows for diagnosis and a more complete understanding of the histologic structure of the liver.[17] The minimum size for adequate liver biopsy is controversial, but studies have reported that a biopsy of 1.5 to 2.5 cm in length may be sufficient.[9,15] In the study by Meral et al.[18] the sample size was found to be 2.98 in 432 trucut biopsy patients. In a study by Gerant Riveara-Sanfeliz et al.[19] the mean liver biopsy length was 2 cm in 152 (98.7%) of 154 patients and this was found to be sufficient for pathologic diagnosis. In our study, the number of specimens taken was significantly higher in aspiration biopsy. Biopsy sizes and number of portal areas were statistically significantly larger in aspiration biopsy compared to tru-cut biopsy. This difference may be due to the larger number of specimens obtained in aspiration biopsy and the use of a small-diameter needle in tru-cut biopsy.

Diagnostic rates; Buscarini et al.[2] in 2091 cases of USG-guided liver biopsy, Buscarini et al. reported an accuracy rate of 95.1% for the core. Gül et al.[11] reported an accuracy rate of 93.8%, which is consistent with the literature. In another study using a sharp needle, the diagnostic rate was 94.3%.[20]

The superiority of cutting needles emerges in the diagnosis of benign and well-differentiated malignant lesions and in determining the type of malignant lesions.[21] One of the most important indications for liver biopsies is to investigate whether the detected focal lesion is malignant.[22] In our study, lesion biopsies were not included.

As with any interventional procedure, some complications may develop in liver biopsy. Transient discomfort localized to the biopsy site, pain with or without anelgesia, vasovagal symptoms,

and vomiting are reported as minor complications.[9,14] The most common complication is pain, which usually disappears spontaneously 1-2 hours after the procedure. There are studies with different results on the relationship between the needle used and pain. Sheets et al.[23] reported that the incidence of pain decreased with the use of automatic needles, while recent studies have reported that automatic needles have a higher incidence of pain than manual needles. This may be due to the shorter duration of the aspiration needle in the liver.[24-27] Gül et al.[11] also reported a higher incidence of pain with tru-cut needle use. Some studies have reported that cutting needle biopsies provide more diagnostic tissue without increasing the complication rate compared to FNAB.[21,28] In our study, pain was observed in 1 patient with tru-cut biopsy and in 2 patients with aspiration biopsy. There was no statistical difference in the occurrence of pain between the two techniques.

Hemorrhage, peritonitis, biliary tract injury, pneumothorax, and hemothorax are major complications after liver biopsy.[9,15] The most common major complication is diffuse bleeding. Post-biopsy bleeding may be intraperitoneal, subcapsular and/or intrahepatic, and hemobilia.[5] Bleeding is symptomatic within three to four hours following biopsy. In the study by Gül et al.[11] the major complication rate was 1.08%. In the study by Özdemir et al.[20] using tru-cut needle, the major complication rate was reported as 1.4%. In the study by Gilmore et al.[9] the complication rate with the use of tru-cut method was 0.35%, while the complication rate with the use of aspiration method was reported as 0.1%. In this study, hemorrhage, pneumothorax, biliary leakage, peritonitis were more common with cutting needles, while other organ injuries and sepsis were more common with the aspiration method. In our study, no major complications developed in any patient who underwent biopsy.

Number of biopsies; Although it has been shown that the diagnostic value of the product obtained when liver biopsy is performed more than once, it has also been clearly shown that multiple procedures increase complication rates. In a study conducted by Maharaj et al.[29] with 2646 biopsy patients, patients were divided into 3 groups: patients who underwent one, two and three procedures, and patients who had no risk of complications before biopsy underwent two and three procedures. While an increase in minor complications was observed in the group with three procedures. No difference was observed in major complications between the three groups. In a study by McGill et al.[10] no correlation was found between the risk of bleeding and the number of procedures. In a study by Cadranel et al.[30] it was found that the rate of complications increased from 26.6% to 68% when the number of procedures increased from one to two. In the study by Gül et al.[11] pain was observed less frequently in the group with 1 procedure compared to the groups with 2 and 3 procedures. In our study, 1 piece was taken from the patient who had tru-cut biopsy and pain occurred, while 3 pieces were taken from 2 patients who had aspiration biopsy and pain occurred. Statistically, there was no significant difference in the number of complications and procedures.

The most important cause of mortality after liver biopsy is intraperitoneal bleeding. According to different studies, the incidence of mortality varies between 0.009% and 0.11%.[1,31] In a study by Gilmore et al.[9] the mortality rate after biopsy was 0.13-0.33%. McGill et al.[10] found the mortality rate due to fatal hemorrhage after percutaneous biopsy to be 0.11%. However, there are many studies in which mortality was not observed.[11,20] In our study, no mortality was observed.

Limitations

Our study has some limitations; firstly, the number of cases was relatively small. Secondly, tru-cut needles were used in the radiology department and aspiration needles in the gastroenterology department. This causes the procedures to be performed by different physicians. Performing all procedures by the same team may provide more accurate information.

CONCLUSION

Percutaneous aspiration and tru-cut biopsies are reliable diagnostic methods with high diagnostic rates and low complication rates. The fact that biopsy is performed by experienced hands, under USG guidance and the number of biopsies is limited reduces the development of complications.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kırıkkale University Ethics Committee approval (Date: 26.06.2024, Decision No: 2024.06.2022).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Journal of Radiology Medicine in

Original Article

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Determination of clinical, radiological and laboratory risk factors associated with the development of pulmonary embolism in patients with lower extremity deep vein thrombosis

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ABSTRACT

Aims: This study aimed to determine the clinical, radiological and laboratory risk factors associated with the development of pulmonary embolism (PE) in patients with lower extremity deep vein thrombosis (DVT) and to determine the role of the triglyceride-glucose (TyG) index.

Methods: In this single-center retrospective study, electronic medical records of patients diagnosed with lower extremity DVT confirmed by ultrasonography (USG) were retrospectively reviewed. Among these patients, patients who underwent computed tomography pulmonary angiography (CTPA) imaging within the first 24 hours with suspected PE and developed PE were identified and recorded. Clinical, radiological and laboratory values of these patients were analyzed with statistical methods and the results were compared.

Results: A total of 236 patients who were diagnosed with lower extremity DVT confirmed by USG and met the inclusion criteria were included in this study. PE was detected in 54 (22.9%) of the included patients. In univariate regression analysis, obesity, diabetes, immobility, thrombus location and high TyG index were identified as risk factors ($p<0.05$ for all). In multivariate regression analysis, diabetes and high TyG index were independent risk factors for PE in patients with DVT ($p<0.05$ for all).

Conclusion: Our study findings indicate that diabetes and high TyG index are independent risk factors for PE in patients with DVT. This suggests that the incidence of PE in patients with DVT can be significantly reduced by controlling diabetes and related factors contributing to high TyG index.

Keywords: Ultrasonography, computed tomography, venous thrombosis, pulmonary embolism, triglyceride-glucose index

INTRODUCTION

Deep vein thrombosis (DVT) is an important public health problem that can lead to serious complications, usually seen in lower extremity veins.[1] Three main factors contribute to the basic mechanism predisposing to DVT formation: decreased blood flow, endothelial damage, and hypercoagulability.[2] The most important risk factors for DVT include oral contraceptive use, pregnancy, thrombophilia, infection, malignancy, immobility, surgery, obesity, and advanced age.[3] Pulmonary embolism (PE), the most important complication of DVT, is one of the leading causes of cardiovascular deaths worldwide.[1] Although PE has various clinical symptoms including hemoptysis and dyspnea, the absence of disease-specific clinical symptoms and signs makes diagnosis difficult.[1] PE occurs with a sudden and dramatic onset and may be fatal.[4] Therefore, detection and treatment of these patients is extremely important. Computed tomography pulmonary angiography (CTPA) is the basic imaging method in the diagnosis of PE. However, this imaging method has disadvantages such as allergic reactions, radiation exposure, potential kidney damage and cost.[5] Considering the high mortality rate of patients with undiagnosed PE, early detection and treatment of PE can significantly reduce the complications that may develop.

It is known that the risk of metabolic and cardiovascular diseases (CVD) increases in individuals with insulin resistance (IR) and is even associated with poor prognosis.[6] IR reduces nitric oxide (NO) production in vascular smooth muscle cells, causing inflammation and endothelial dysfunction. It also

activates inflammatory cell cytokine producers that contribute to oxidative stress and increases the release of procoagulant factors, causing platelet aggregation.[7] The triglyceride-glucose (TyG) index is considered a reliable indicator of IR.[8] TyG index has been associated with CVD such as coronary artery disease (CAD), carotid atherosclerosis, hypertension, and coronary artery calcification in several studies.[9-11] In fact, TyG index has been found to be closely related to CVD development and prognosis, independent of traditional risk factors.[10,12,13] However, we did not find any study examining the relationship between PE and TyG index in patients with DVT.

This study aimed to determine the clinical, radiological and laboratory risk factors associated with the development of PE in patients with lower extremity DVT and to determine the role of the TyG index.

METHODS

Ethics

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethics Committee Approval was obtained from the Siirt University Non-invasive Ethics Committee (Date: 05.07.2024, Decision No: 112266).

Study Design and Subjects

In this single-center retrospective study, electronic medical records of patients diagnosed with lower extremity DVT confirmed by ultrasonography (USG) between January 2018 and June 2024 were retrospectively reviewed. Among these patients, those who underwent CTPA imaging within the first 24 hours with suspected PE and in whom PE was detected were identified and recorded.

Patients with a known or detected history of malignancy, those younger than 18 years of age, those with incomplete medical records, those diagnosed with chronic DVT, those diagnosed with upper extremity DVT, those receiving any anticoagulant treatment, those previously diagnosed with PE, and those with arterial or superficial venous thrombosis were excluded from the study.

Data Collection

Data on clinical and demographic characteristics of all patients including gender, age, smoking and presence of major cardiovascular risk factors (diabetes, hypertension, smoking, dyslipidaemia) were collected and recorded. The inclusion criteria for diabetes mellitus, hypertension and hyperlipidaemia were defined as being diagnosed and/or receiving medication for these diseases. At least 10 cigarettes a day for at least 1 year was determined as a criterion for smoking. Fasting blood glucose, total cholesterol (TC), triglycerides (TG), low density lipoprotein-C (LDL-C), high density lipoprotein-C (HDL-C), serum albumin, total protein, sedimentation (ESR), C-reactive protein (CRP) and haematological parameters (Hg, neutrophil, lymphocyte, platelet and leukocyte levels) were analysed and recorded in the laboratory information system. Patients with fasting triglyceride and glucose measurements within 24 hours after diagnosis were included in the study. TyG index was calculated as follows: TyG=Ln [fasting TG (mg/dl)xfasting glucose (mg/dl)/2].[14]

The Sonographic Procedure

USG reports of all patients were accessed from the electronic medical record system and data on radiological imaging features of the disease were obtained. Patients without an USG report in the system were excluded from the study. In USG reports, the presence of a non-compressible venous segment in the lower extremity veins, the presence of thrombus in the lumen, or the absence of colored flow were defined as DVT. The location of the thrombus was classified as proximal type if it was in the popliteal vein or above, as distal type if it was below the popliteal vein, and as mixed type if it was in both distal and proximal veins.

CT Protocol and Analysis

CTPA images of all patients diagnosed with PE were retrospectively re-evaluated via picture archiving and communication system (PACS). The presence of thrombus causing a complete or partial filling defect in the pulmonary arteries was accepted as PE (**Figure 1**).

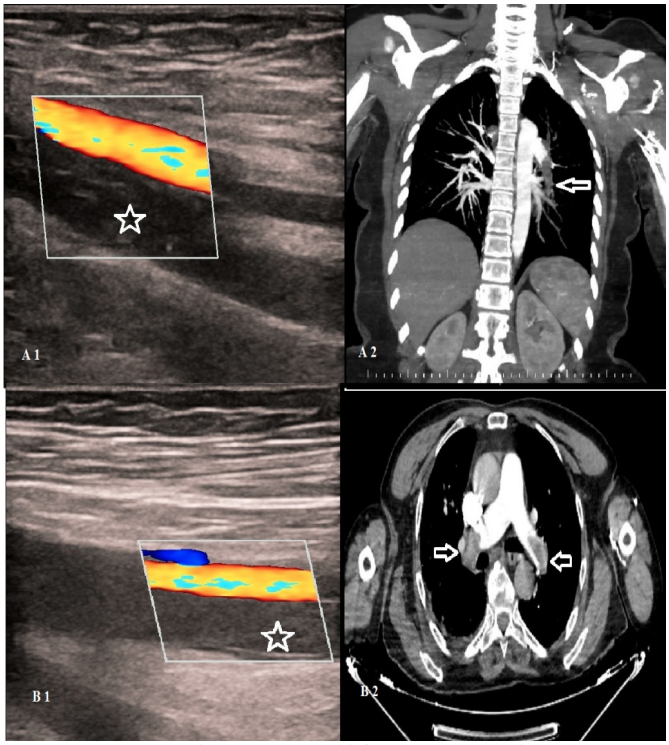

Figure 1. Case examples. A 32-year-old female patient with no known risk factors and a Tyg index of 8.95 is shown to have acute DVT in the right superficial femoral vein on USG Doppler examination (A1) and embolism findings in the left pulmonary artery lumen on CTPA images of the same patient (A2). A 72-year-old male patient with a TyG index of 9.40, known to have diabetes, hypertension and smoking history, shows a DVT in the right superficial femoral vein that does not allow flow on USG Doppler examination (B1) and bilateral pulmonary artery embolism findings on CTPA images (B2).

Statistical Analysis

SPSS 20.0 software (Statistical Package for the Social Sciences, Chicago, IL) was used for data analysis. Qualitative data were expressed as number (n) and percentage (%) and quantitative data were expressed as mean±standard deviation (SD).

During data analysis, Student's t test was used for variables showing normal distribution and Mann-Whitney U test was used for variables not showing normal distribution in comparisons between groups. Chi-square test or Fisher's exact test was applied to analyze the relationship between categorical data depending on the sample size. Univariate and Multivariate Binary Logistic Regression analyses were used to determine risk factors for PE. ROC (receiver operating characteristic) curve analysis was used to determine whether the TyG index is a prognostic indicator for predicting the risk of PE and to determine the optimum cut-off values. The significance level for statistical results was accepted as $p<0.05$.

RESULTS

A total of 236 patients with USG-confirmed DVT who fulfilled the inclusion criteria were included in this study. PE was detected in 54 (22.9%) of the included patients. The mean age at diagnosis of patients with PE was 62.5±10.8 years and the mean age of patients without PE was 63.7±9.6 years. Of the patients with PE, 21 (38.8%) were male and 33 (61.2%) were female. There were no statistically significant differences between patients with and without PE in age, gender, smoking history, HT and CAD (p>0.05 for all). Body-mass index was 27.8±4.3 kg/m^2 in patients with PE and 26.4±3.8 kg/m^2 in patients without PE (p=0.024, **Figure 1**). The presence of immobilisation and diabetes were statistically higher in the group of patients with PE (p=0.039, p<0.001, respectively). The most common thrombus location in patients with PE was found to be proximal type with 40.7% (p=0.026). When laboratory parameters were compared, no statistically significant difference was found between the two groups in laboratory parameters such as ESR, CRP, fasting glucose, LDL, TC, HDL and D-dimer and haematological values (WBC, neutrophil, lymphocyte, platelet and leukocyte levels) (p>0.05 for all). However, triglyceride value was statistically higher in patients with PE (p= 0.037). TyG index was significantly higher in patients with PE than in patients without PE (p<0.001, **Figure 2**). The basic clinical and laboratory data of the patients included in the study are presented in **Table 1**.

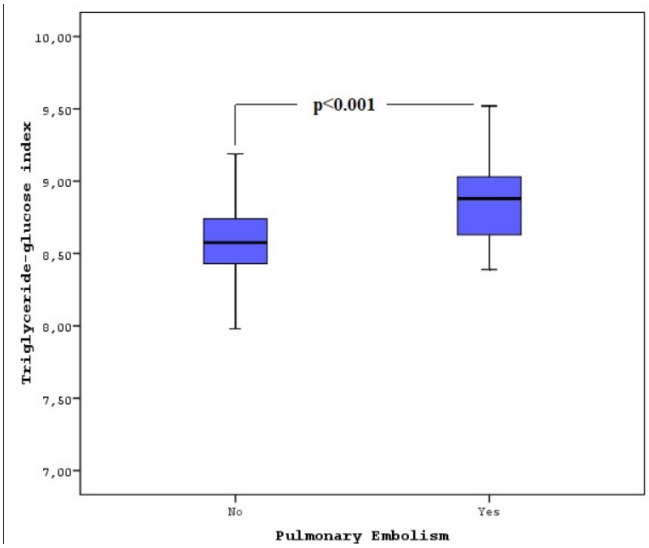

Figure 2. Box plot of the distribution of TyG index values in patients with DVT with and without PE. The horizontal lines within each box represent the mean values, and the lower and upper rows of each box represent the minimum and maximum values, respectively.

In the ROC curve analysis test of the TyG index, the AUC values were determined as 0.746 (0.668-0.823), respectively, at a 95% confidence interval and were therefore considered statistically significant (p<0.001, **Figure 3**). Accordingly, when the cut-off value of the TyG index was taken as ≥8.75 in determining the risk of PE in patients with DVT, the sensitivity was determined as 70.4% and the specificity as 76.9%.

Regression analysis was used to determine the risk of PE in patients diagnosed with DVT. In univariate regression analysis, obesity (yes or no), diabetes (yes or no), immobility (yes or no), thrombus location (proximal type versus distal and mixed type) and high TyG index (≥8.75) were identified as risk factors. In multivariate regression analysis, diabetes (p=0.001, OR: 3.65; 95% confidence interval (CI), 1.68-7.92) and TyG index cut-off value above 8.75 (p=0.005, OR: 11.2; 95% confidence interval (CI), 5-24.9) were independent risk factors for PE in patients with DVT (**Table 2**).

DISCUSSION

It has been reported that PE is seen in 50-60% of DVT patients, while DVT is seen in 13-93% of PE patients.[15] The clinical diagnosis of PE is nonspecific and the screening test D-dimer has a very low specificity despite its high sensitivity. Although CTPA is the most commonly used imaging method in patients with suspected PE, radiation exposure is its most important disadvantage.[15] Determining and identifying risk factors that are effective in the development of PE is very important in preventing serious complications such as mortality and morbidity. In this study, we analyzed clinical, radiological and laboratory risk factors associated with PE and found that the TyG index may be an important factor in the development of PE in patients with DVT.

TyG index has been reported to be a highly sensitive and reliable marker used in determining IR.[16] In recent years, the relationship between the TyG index and many cardiovascular and cerebrovascular events has attracted increasing attention. It has been reported that high TyG index is an important risk factor for CAD and is associated with the number of stenotic coronary arteries and the degree of stenosis.[10,17] Cerebrovascular disease with a high TyG index has been associated with more rapid neurological deterioration and increased mortality.[18,19] Recent studies suggest that venous thromboembolism is part of a "pan-cardiovascular syndrome" because they all result from the same pathophysiological processes, including hypercoagulability, endothelial damage, and inflammation.[20] To our knowledge, this current study is the first to investigate the relationship between TyG index and PE in patients with DVT. Our findings revealed that DVT patients with high TyG index had a higher risk of PE, and even high TyG index was an independent risk factor for PE in patients with DVT in multivariate logistic regression analysis.

It seems possible that the relationship between TyG index and PE may be mediated by several mechanisms. It is known that IR causes endothelial dysfunction and increases platelet activation.[21-24] Blood levels of fibrinolysis inhibitors such as plasminogen activator inhibitors are increased in patients with high IR.[25] In addition, IR may cause the thrombus to become more dense and become more resistant to lysis.[26] These events may explain the pulmunary thromboembolism that develops in DVT patients with high IR.

There are studies reporting that long-term immobilization is a clinical risk factor for PE.[27,28] Being bedridden for a long time can cause blood flow to slow down and small thrombi to coalesce to form larger thrombi.[29,30] Obesity is one of the leading causes of venous thromboembolism.[31] It has been determined that this risk increases as BMI increases and even becomes more pronounced when combined with other risk factors.[31,32] Adipokines secreted from adipose tissue may affect platelet function and cause endothelial damage.[21] In this study, we found that increased BMI and immobilization were risk factors for PE in patients with DVT in univariate regression analysis.

Table 1. Comparison of baseline characteristics and variables of the study patients

	Pulmonary embolism			
Parameters	No (n=182)	Yes (n=54)	Total (n=236)	p values
Age (years)	63.7±9.6	62.5±10.8	63.4±9.9	0.455[a]
Gender, n (%) Male Female	 82 (45.1%) 100(54.9%)	 21(38.8%) 33(61.2%)	 103(43.6%) 133(56.4%)	0.422[c]
BMI (kg/m^2)	26.4±3.8	27.8±4.3	26.7±3.9	**0.024[a]**
Smoking, n (%) No Yes	 133 (73.1%) 49 (26.9%)	 35 (64.8%) 19 (35.2%)	 168 (71.1%) 68 (28.9%)	0.239[c]
HT, n (%) No Yes	 128 (70.3%) 54 (29.7%)	 34 (62.9%) 20 (37.1%)	 162 (68.6%) 74 (31.4%)	0.306[c]
DM, n (%) No Yes	 142 (78.1%) 40 (21.9%)	 29 (53.7%) 25 (46.3%)	 171 (72.5%) 65 (27.5%)	**<0.001[b]**
CAD No Yes	 135 (74.2%) 47 (25.8%)	 35 (64.8%) 19 (35.2%)	 170 (72.1%) 66 (27.9%)	0.178[c]
Dyslipidemia, n (%) No Yes	 126 (69.2%) 56 (31.8%)	 34 (62.9%) 20 (37.1%)	 160 (67.8%) 76 (32.2%)	0.387[c]
Immobility No Yes	 143 (78.5%) 39 (21.5%)	 35 (64.8%) 19 (35.2%)	 178 (75.5%) 58 (24.5%)	**0.039[c]**
Location of DVT Proximal Distal Mix	 44(24.2%) 83(45.7%) 55(30.1%)	 22(40.7%) 15(27.8%) 17(31.5%)	 66(27.9%) 98(41.5%) 72(30.6%)	**0.026[c]**
WBC (10^9/L)	8.6±2.9	9.7±2.3	8.8±2.8	0.014[d]
CRP (mg/dl)	2.4±1.8	2.3±1.1	2.3±1.7	0.590[d]
ESR (mm/h)	27.8±11.9	26.8±11.5	27.6±11.8	0.614[d]
Neutrophil (10^9/L)	4.7±1.6	5.1±1.7	4.8±1.6	0.124[d]
Lymphocyte (10^9/L)	2.1±0.9	2.1±1	2.1±0.9	0.410[d]
PLT (10^9/L)	287±52	294±54	289±53	0.390[d]
HDL (mg/dl)	38.4±10.4	35.6±9.3	37.8±10.2	0.079[d]
LDL (mg/dl)	118.2±19.8	124.2±21.1	119.3±20.2	0.058[d]
Total cholesterol (mg/dl)	191.7±29.7	200.4±30.7	194.4±30.5	0.063[d]
Triglyceride (mg/dl)	133.5±39.7	147.2±51.8	136.5±43.1	**0.037[d]**
Glucose (mg/dl)	96.9±14.4	101.8±22.9	98.1±16.8	0.06[d]
TyG index	8.58±0.29	8.85±0.38	8.64±0.32	**<0.001[d]**
D-dimer (ng/ml)	4645±3914	5444±4409	4828±4037	0.202[d]

Notes: [a]Student's t-test with mean±standard deviation (SD). [b]Fisher's Exact test with n (%). [c]Chi-Square with n (%). [d]Mann Whitney U-test with median±interquartile range (IQR). Statistically significant results (p<0.05).
Abbreviations: BMI: Body-mass index, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, DVT: Deep vein thrombosis, HB: Hemoglobin, WBC: White blood cell count, CRP: C-reactive protein, ESR: Eritrocyte sedimentation rate, PLT: Platelets, TyG: Triglyceride-glucose index, HDL: High density lipoprotein; LDL: Low density lipoprotein

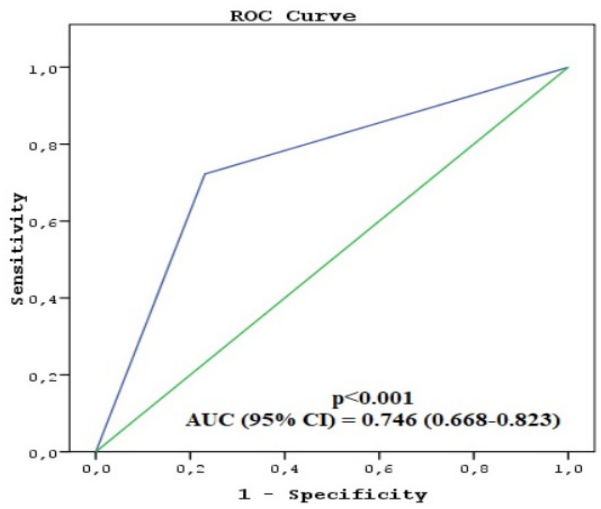

Figure 3. Receiver operating characteristic (ROC) curve and area under the ROC (AUC) of TyG index values in PE development

There are many studies reporting that diabetes is an independent risk factor for the development of PE.[33-37] Pathophysiologically, hyperglycemia-induced endothelial cytotoxicity and endothelial dysfunction, independent of insulin, induce a procoagulant and proinflammatory state, potentially leading to a prothrombotic environment in diabetic patients.[38,39] Chung et al.[33] found that diabetes increases the incidence of PE in a large nationwide study. This study findings revealed that diabetes was an independent risk factor for PE in multivariate logistic regression analysis, consistent with the literature.

It has been shown that the type of DVT that increases the risk of PE the most is the proximal type compared to other types.[32,40,41] Zhang et al.[1] reported that proximal-type DVT is an independent risk factor for PE. Konstantinides et al.[42] demonstrated that distal type DVT is stable and therefore less associated with PE. In this study, we found that the proximal

Table 2. Univariate and multivariate binary logistic regression analysis results to determine risk factors effective in pulmonary embolism

	Univariate		Multivariate	
	p values	OR (CI 95%)	p values	OR (CI 95%)
Obesity (BMI>30 kg/m²) Yes against no	0.037	1.96 (1.04-3.72)	ns	
DM Yes against no	<0.001	3.06 (1.61-5.8)	0.001	3.65 (1.68-7.92)
Immobility Yes against no	0.039	1.99 (1.02-3.85)	ns	
Location of DVT Proximal against distal and mix	0.013	0.45 (0.24-0.85)	ns	
TyG index ≥8.75 against <8.75	<0.001	8.66 (4.35-17.24)	0.005	11.2 (5-24.9)

Note: Statistically significant results (p<0.05).
Abbreviations: ns: Not significant, OR: Odds ratio, CI: Confidence interval, BMI: Body-mass index, DM: Diabetes mellitus, DVT: Deep vein thrombosis TyG: Triglyceride-glucose index

type was a risk factor for PE compared to other types in patients with DVT in univariate regression analysis.

Limitations

Our study had several important limitations. First, the retrospective nature of the study and its single-center nature prevented us from extrapolating our findings to the population. Secondly, due to the relatively small number of patients, future multicentre studies with a larger number of patients are needed to support our findings.

CONCLUSION

In conclusion, our findings suggest that diabetes, obesity, immobilisation, thrombus location and high TyG index are risk factors for PE in patients with lower extremity DVT, whereas diabetes and high TyG index are independent risk factors. This suggests that the incidence of PE in patients with DVT can be significantly reduced by controlling diabetes and associated factors contributing to high TyG index.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethics committee approval was obtained from the Siirt University Non-invasive Ethics Committee (Date: 05.07.2024, Decision No: 112266).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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mp-MRI of prostate gland with PI-RADS v2.1 assessment: correlation with fusion biopsy results

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ABSTRACT

Aims: The aim of our study is to evaluate the correlation of patients reported as 3, 4 and 5 according to 'prostate imaging reporting data system' (PI-RADS v2.1) on 1.5 and 3 Tesla (T) multiparametric prostate magnetic resonance imaging (mp-MRI) with fusion biopsy results and to find out the effectiveness of mp-MRI in directing to fusion biopsy.

Methods: Between 2017 and 2020, a total of 73 patients who underwent targeted fusion biopsy were retrospectively included in the study. The patients had biopsy from a total of 116 lesions reported as PI-RADS 3, 4 and 5 on the mp-MRI examinations. In our department, only one MRI device has been utilized for prostate imaging. Before June 2018, a 1.5T MRI was used; after this date, a 3T MRI has been in operation. MRI images were re-examined independently by two radiologists. Both radiologists used PI-RADS v2.1 criteria for lesion scoring, since all the images were evaluated retrospectively.

Results: When the diagnosis of significant and insignificant cancers were considered together; with MRI, observer 1's sensitivity 93.10%, specificity 58.62%, positive predictive value (PPV) 42.85% and negative predictive value (NPV) 96.22%, observer 2's sensitivity 89.65%, specificity 68,96%, PPV 49% and NPV 95.25% was calculated. When only clinically significant cancers were considered; observer 1's sensitivity 87.5%, specificity 69.11%, PPV 66.66% and NPV 88.67%, observer 2's sensitivity 83.33%, specificity 80.88%, PPV 75.47% and NPV 87.30% was calculated. In the kappa test which was performed to calculate interobserver agreement between the two observers; k=0.801 was calculated and found to be substantial agreement ($p<0.01$).

Conclusion: The high rate of malignant lesions scored as PI-RADS 4 and 5 in prostate MRI reveals that these patients should be directed to biopsy. Focus-oriented biopsy using MRI guidance increases the PPV and prevents unnecessary systemic biopsies and complications.

Keywords: Prostate cancer, PI-RADS, multiparametric MRI, fusion biopsy

INTRODUCTION

We need more accurate diagnostic methods to reduce the overdiagnosis and overtreatment of clinically insignificant prostate cancer, improve detection of clinically significant prostate cancer, and reduce the number of unnecessary biopsy procedures.[1] Multiparametric prostate magnetic resonance imaging (mp-MRI) has an important role in noninvasive imaging, localization and staging of suspicious lesions in the prostate gland.[2,3]

With widespread use of mp-MRI and its better standardization, the ability to detect and rule out clinically significant cancer has improved in recent years.[4-6] Studies have shown that MRI-targeted biopsies detect high-grade cancers at a higher rate than systematic biopsy.[7-10]

mp-MRI before biopsy or MRI-targeted biopsy is an alternative to standard transrectal ultrasonography (TRUS) guided biopsy in men with suspected prostate cancer.[11,12] mp-MRI can be used to avoid a biopsy if its results are negative and it can also be used to target abnormal areas in the prostate during biopsy.[4,13,14]

In our clinic, mp MRI is performed in all patients with suspected prostate cancer, and if a suspicious lesion is detected, transperineal fusion biopsy is performed.

The aim of our study is to evaluate the correlation of patients reported as prostate imaging reporting data system (PI-RADS v2.1) 3,4 and 5 on 1.5 and 3 tesla (T) mp-MRI with fusion

biopsy results and to find out the effectiveness of mp-MRI in directing to fusion biopsy.

METHODS

The study was conducted with the permission of TOBB-ETU Faculty of Medicine Clinical Researches Ethics Committee (Date: 26.06.2020, Decision No: KAEK-118/087). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. This retrospective study is approved by our institutional review board (26.06.2020/KAEK-118/087) and the requirement for informed consent from patients was waived.

Study Population

Between 2017-2020, 73 patients with high prostate-specific antigen (PSA) values, rapid PSA elevation, abnormal digital rectal exam findings, family history or benign findings from prior TRUS biopsy underwent mp-MRI and targeted biopsy at our institution.

A total of 116 lesions previously reported as PI-RADS 3, 4 and 5 on the mp-MRI examinations were biopsied. The mean age of the patients was 62.43±7.8, with a median PSA value was 10.34 ng/ml (range: 1.0-100 ng/ml), and a median prostate volume of 51.25 cm^3 (range: 20-150 cm^3).

The exclusion criteria in our study was the patients whose biopsies or mp-MRI were performed in other institutions. We also excluded patients for whom we could not perform fusion biopsy due to the inability to administer anesthesia.

mp-MRI Protocol and Image Analysis

All mp-MRI examinations included anatomic T2-weighted and T1-weighted imaging, diffusion-weighted imaging (DWI) and dynamic contrast enhanced imaging (DCE). In our department, only one MRI device has been utilized for prostate imaging. Before June 2018, a 1.5T (Symphony, Siemens, Germany) MRI was used; after this date, a 3T (Ingenia, Philips Medical Systems, Netherlands) MRI has been in operation. The difference in MRI field strengths did not create any diagnostic challenges, as the imaging protocols were optimized for both systems to ensure consistency in lesion evaluation. When the patient population was divided into 1.5T and 3T groups, the number of patients was statistically insufficient, and therefore, a comparision could not be performed. The imaging difference between 1.5T and 3T MRI did not affect the biopsy protocol. 27 patients were examined with 1.5T, 46 patients were examined with 3T. T2-weighted images were obtained on axial, sagittal and coronal planes, DWI and DCE images were obtained on the axial plane. For the 1.5T device, the "b" values for DWI were 50, 750, 1500 s/mm^2. On 3T device, DWI were obtained with "b" values 0, 1500 s/mm^2, but on 3T device ADC maps were created from 0, 200,1000 s/mm^2 b values to reduce the effect of kurtosis. For DCE imaging, all patients were injected intravenously 0.2ml/kg gadoterate meglumine (Dotarem; Guerbet, Roissy, France) with an injection rate of 3ml/s. In the 3T device, 44-channel spine coil and 32-channel phased array body coils; in 1.5T device, 32-channel spine coil and 8-channel phased array body coils were used.

DWI and axial T2 images were obtained with a 3-mm section thickness for fusion combining. Axial sections were taken without inclination for compatibility with fusion biopsy images. The temporal resolution was determined as 15s for 1.5T and 3T imaging.

MRI images were re-examined independently by two radiologists. One of the radiologists had 15 years of experience and the other had 6 years of experience in abdominal imaging. Radiologists were unaware of patients' pathology reports and only knew how many patients underwent fusion biopsy and how many lesions were biopsied. Both radiologists used PI-RADS v2.1 criteria for lesion scoring, since all the images were evaluated retrospectively. PI-RADS v2.1 scoring was performed by evaluating the localization of suspected lesions on peripheral and transitional zones and evaluating T2-weighted, DWI and DCE images.

PI-RADS scores 4 and 5 were considered as high probability for malignancy and compared with the biopsy finding diagnosed as clinically insignificant (Gleason 3+3) and clinically significant cancers (Gleason≥3+4).

Transperineal Fusion Biopsy Technique

Patients underwent a transperineal biopsy in a day surgery unit. We carried out the procedure under general anesthesia and in the lithotomy position. All patients were administered cephazolin parenterally for pre-procedural prophylaxis. Scrotum was lifted up by firm dressing after perineal cleaning for better visualization of perineum. The prostate was imaged after insertion of real-time transrectal ultrasound view which was fused with pre-procedural drawn MRI scenes by Biojet (Barum, Germany) MRI-US fusion biopsy software. A biopsy template grid fixed to a cradle was placed near the perineum. An 18G biopsy needle was directed through the biopsy grid under transrectal US probe and minimum of three pieces were taken from each suspected area and also from random areas. All patients were discharged on same day after a short follow-up. There was no serious complications noted after the procedure.

Histopathological Analysis

Hematoxylin and eosin stained slides of all biopsy materials that were suspicious for prostatic adenocarcinoma were examined microscopically. Some of biopsy slides also had immunostainings of antibodies against HMWCK and p63. Prostatic adenocarcinoma was diagnosed and graded according to Gleason score.

Statistical Analysis

If normality assumption is provided for numerical variables as descriptive statistics in our study, the mean±std. deviation; if it is not provided, the median (min-max) is given. The agreement between observer 1 and observer 2 was evaluated with kappa method. Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV) were calculated according to the results of the observers. Type I error probability was determined as 0.05 in all analyses. All the statistical calculations of the study were done using IBM SPSS V22 program (IBM, SPSS Corp.; Armonk, NY, USA).

RESULTS

In our study, the observer 1 reported 23 lesions as PI-RADS 2, 32 lesions as PI-RADS 3, 50 lesions as PI-RADS 4, and 11 lesions as PI-RADS 5. The observer 2 reported 25 lesions as PI-

RADS 2, 41 lesions as PI-RADS 3, 38 lesions as PI-RADS 4 and 12 lesions as PI-RADS 5. A total of 48 pathologically positive lesions were diagnosed from the biopsy specimens. Pathology scores are as follows: 19 with Gleason score 3+3 (**Figure 1**); 20 with Gleason score 3+4 (**Figure 2**); 3 with Gleason score 4+3 (**Figure 3**); 2 with Gleason score 4+4; 2 with Gleason score 4+5; 1 with Gleason score 5+4; 1 with Gleason score 5+5. We reported 82 of the lesions in the peripheral zone and 34 in the transitional zone.

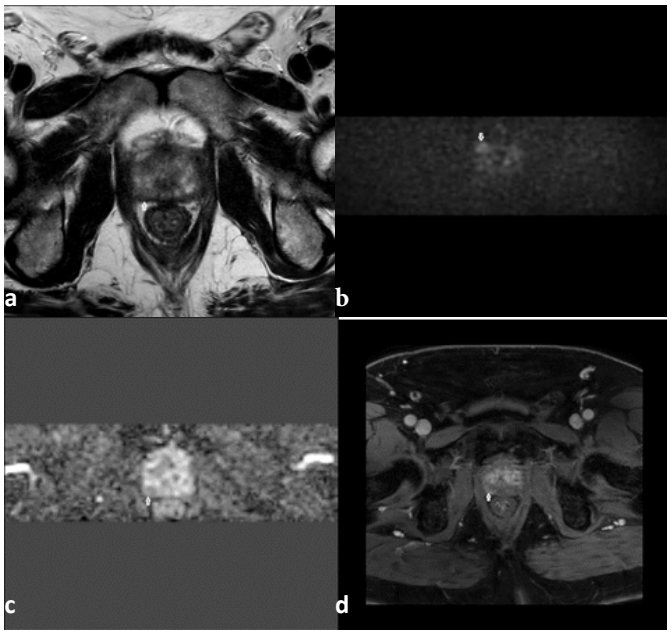

Figure 1. 55-year-old patient with PSA 6.53 ng/ml, right peripheral zone hypointense area on T2 (**a**), minimal hyperintense focal area on DWI (**b**), hypointense focal area on ADC (**c**) and there is early arterial phase contrast enhancement in dynamic contrast images (**d**) PIRADS 4 lesion. Fusion biopsy result was compatible with Gleason score 3+3

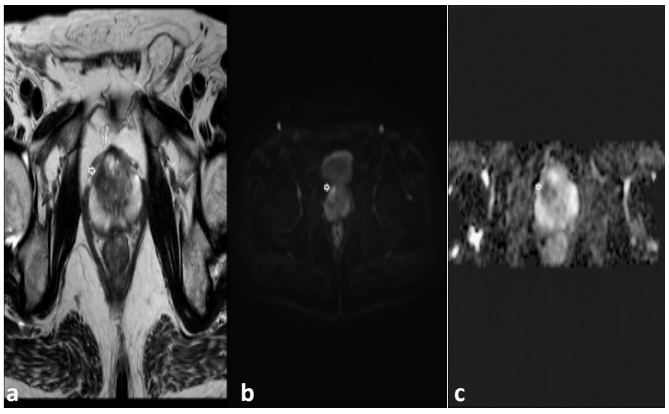

Figure 2. 68-year- old patient with PSA 6.8 ng/ml, right transitional zone hypointense area on T2 (**a**), hyperintense on DWI (**b**), hypointense on ADC (**c**) PIRADS 5 lesion. Fusion biopsy result was compatible with Gleason score 3+4

Of the lesions reported as PIRADS 3 and 4 and biopsied in the period before the PIRADS v2.1 criteria began to be used; the observer 1 reported 23 lesions and the observer 2 reported 25 lesions as PI-RADS 2 in this evaluation (**Figure 4**).

When ≥Gleason 3+3 lesions are evaluated; observer 1's sensitivity was calculated as 93.10%, specificity 58.62%, PPV 42.85% and NPV 96.22%, observer 2's sensitivity was calculated as 89.65%, specificity 68,96%, PPV 49% and NPV 95.25%. When ≥ Gleason 3+4 lesions are evaluated; observer 1's sensitivity was calculated as 87.5%, specificity 69.11%,

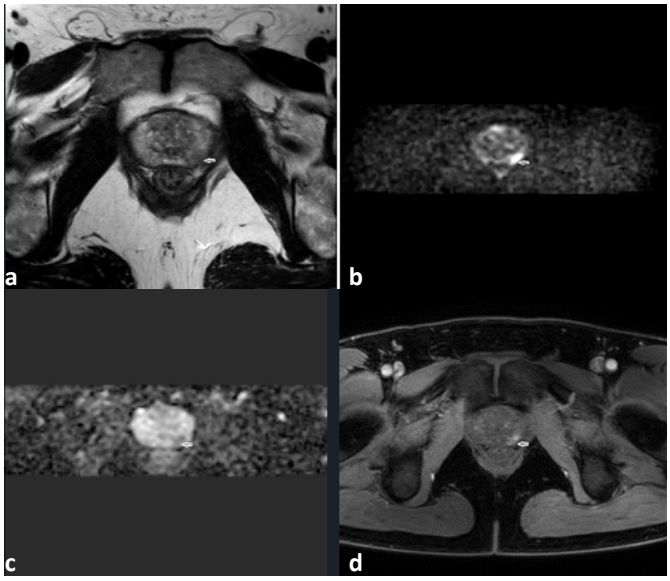

Figure 3. 55-year-old patient with PSA 5.63 ng/ml, left peripheral zone hypointense area on T2 (**a**), hyperintense on DWI (**b**), hypointense on ADC (**c**), early arterial phase contrast enhancement in dynamic contrast images (**d**) PIRADS 4 lesion. Fusion biopsy result was compatible with Gleason score 4+3

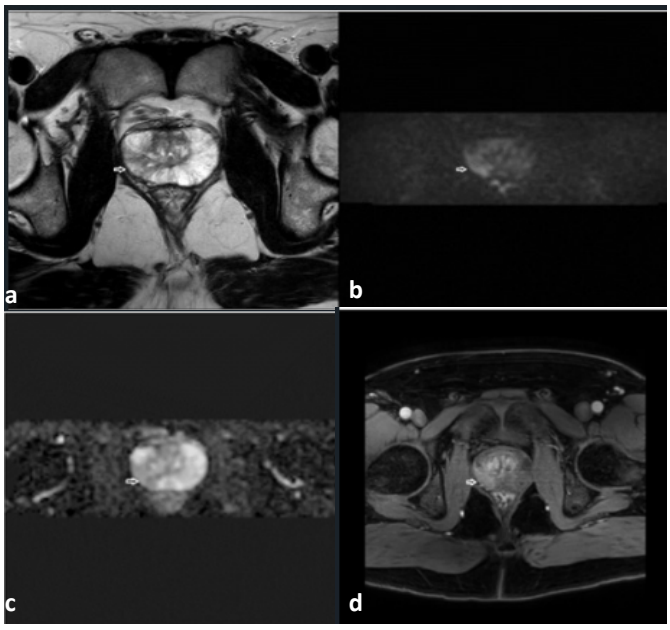

Figure 4. 52-year-old patient with PSA 9.4 ng/ml, right peripheral zone hypointense area on T2 (**a**), hyperintense on DWI (**b**), hypointense on ADC (**c**) , early arterial phase contrast enhancement in dynamic contrast images (**d**) PIRADS 2 lesion. Fusion biopsy result was compatible with prostatitis

PPV 66.66% and NPV 88.67%, observer 2's sensitivity was calculated as 83.33%, specificity 80.88%, PPV 75.47% and NPV 87.30% (**Table 1 and 2**).

In the kappa test which was performed to calculate interobserver agreement between the two observers; k=0.801 was calculated and found to be substantial agreement (p<0.01).

Table 1. Overall sensitivity, specificity, PPV, NPV for clinically significant and insignificant cancers

Clinically significant and nonsignificant	OBSERVER 1	OBSERVER 2
Sensitivity (%)	93.10	89.65
Specificity (%)	58.62	68.96
PPV (%)	42.85	49
NPV (%)	96.22	95.25

PPV: Positive predictive value, NPV: Negative predictive value

Table 2. Sensitivity, specificity, PPV, NPV for clinically significant cancer

Clinically significant	OBSERVER 1	OBSERVER 2
Sensitivity (%)	87.5	83.33
Specificity (%)	69.11	80.88
PPV (%)	66.66	75.47
NPV (%)	88.67	87.30

PPV: Positive predictive value, NPV: Negative predictive value

DISCUSSION

In our clinic, transperineal fusion biopsy is performed on all patients in order to reduce side effects of transrectal biopsy and to detect clinically significant cancers at a high rate, thus preventing unnecessary biopsy and treatment. Therefore, mp-MRI is performed in all patients with suspected cancer before making a biopsy decision.

In a randomized prospective study, Panebianco et al.[15] have shown the advantages of MRI- based diagnostic pathway over TRUS guided biopsy. They found a higher rate of clinically significant cancer in the group that underwent mp-MRI/biopsy compared to TRUS biopsy. Also found that mp-MRI is a very reliable method to identify patients to schedule in active surveillance.

Hoeks et al.[16] reported a 25% cancer detection rate in patients with at least once a negative biopsy history for increased PSA and then with mp-MRI and MRI-guided bore biopsy, and 87% of these cancers were clinically significant. The PPV of this study was 41%.

Following the first negative biopsy, Sonn et al.[17] detected cancer in 34% of patients using MRI-US fusion biopsy and the PPV of mp-MRI for only high or very high suspicious (grade 4 and 5) lesions was 50%.

Siddiqui et al.[7] found that targeted MRI/ultrasound fusion biopsy increased the detection of high-risk prostate cancer and decreased low-risk prostate cancer detection compared to standard biopsy. The sensitivity of the targeted biopsy was 77%.

In a multicenter randomized controlled study, it was shown that mp-MRI before biopsy and MRI targeted biopsy were diagnostically superior to TRUS biopsy.[11] In a cochrane systemic review and meta-analysis, it was concluded that the MRI pathway is a more useful diagnostic test than systemic biopsy in men with clinically significant cancer suspicion. Therefore, any pre-biopsy mp-MRI examination should be included in the diagnostic study.[12]

Unlike these studies, systemic biopsy comparison was not performed in our study. In our institution, we use the fusion biopsy method in order to reduce complications, provide more accurate diagnosis and make it more comfortable for the patient. Our aim was to investigate the efficacy of mp-MRI in directing fusion biopsy for the detection of cancer. Compared to other studies, sensitivity and specificity yielded similar value ranges, but PPV of mp-MRI was higher than other studies. The difference of our study from these studies is to perform mp-MRI to all patients before biopsy and take it from the suspicious lesion directly by transperineal fusion biopsy. We think that this approach increased our PPV.

4 lesions Gleason 3+3, 1 lesion Gleason 3+4, was reported as PI-RADS 3 by observer 1, 5 lesions Gleason 3+3, 2 lesions Gleason 3+4, 1 lesion Gleason 4+3 was reported as PI-RADS 3 by observer 2. We thought that the reason why observer 2 reported more clinical significant cancers in lesions reported as PI-RADS 3 compared to observer 1 was due to observer 2 had less experience in reporting mp-MRI compared to observer 1. From these results, we think that PI-RADS 3 lesions reported by radiologists experienced in mp-MRI can be followed-up without biopsy.

In most of the other studies, only clinically significant cancers were included in the study. In our study, we evaluated both clinically significant and clinically insignificant cancers together and only clinically significant cancers. The reason we evaluated the two separately is because Gleason score 3+3 patients all require close follow-up and some of these patients who do not want to be followed for a long time are included in the treatment protocol. These patients are good candidates for targeted therapy before the lesion's dimensions are increased. That's why we think that these patients should also be diagnosed and followed accordingly. In the evaluation made, our PPV and specificity increase and our NPV and sensitivity decrease when only clinical significant cancers are included. However, we need a higher number of patients to understand the reason for this.

Active and chronic prostatitis and atypical small acinar proliferation (ASAP) are the main causes of false positive findings in our patients. In one of our patients, first MRI examination was evaluated as acute prostatitis but follow-up MRI showed localized more rounded T2 hypointense area with positive DWI findings and then the patient was directed to fusion-biopsy.

A good inter-observer agreement of MRI findings was found for cancer-positive lesions proven at biopsy. The reason for the high inter-observer agreement is that we used the standardized v2.1 criteria in the evaluation.

Limitations

Our trial has limitations. The most important limitation of our study is the small number of patients. Second, we can't compare our results with standard biopsy since only transperineal fusion biopsy was performed in our clinic.

CONCLUSION

In conclusion the high rate of malignant lesions scored as PI-RADS 4 and 5 in prostate MRI reveals that these patients should be directed to biopsy. Focus-oriented biopsy with US-MRI fusion biopsy techniques increases the PPV and prevents unnecessary systemic biopsies and complications. When appropriate sequences were used in 1,5T and 3T prostate mp-MRI, the detection rate of non-malignant lesions was also high. In this way, complications that may occur secondary to the patients' exposure to unnecessary invasive procedures are prevented.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of TOBB-ETU Faculty of Medicine Clinical Researches Ethic Committee (Date: 26.06.2020, Decision No: KAEK-118/087).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Fistula between splenic artery aneurysm and colon lumen as an unusual cause of lower gastrointestinal tract bleeding and endovascular treatment

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ABSTRACT

The patient, who had undergone a liver transplant 15 years prior due to autoimmune hepatitis and was subsequently followed for chronic portal hypertension, presented to our emergency department in the evening with abdominal pain and melena. This case report aims to present an uncommon cause of lower gastrointestinal bleeding, which is a fistula between the splenic artery and the colon lumen, as well as the fistula's diagnostic process and endovascular treatment.

Keywords: Splenic artery aneurysm, splenocolic fistula, melena, lower gastrointestinal bleeding, splenic artery embolisation

INTRODUCTION

This paper sets out the case of a 40-year-old female patient who presented to the emergency department of our hospital at approximately 10 p.m. with the complaint of severe stomachache and melena. Her medical history revealed that the patient had undergone a liver transplant at a different medical center in 2010 due to decompensated cirrhosis secondary to autoimmune hepatitis. In 2017, portal vein thrombosis was detected, and the patient commenced low-molecular-weight heparin therapy. In 2018, the development of ascites was observed, but it was managed with diuretic medications. Although bleeding fistula between the splenic artery and the colonic lumen have been rarely reported in the literature, they have generally been treated surgically.[1] In addition, chronic portal hypertension has been shown to cause splenic artery aneurysms in rare cases, as in our patient.[2]

CASE

The patient exhibited elevated liver enzymes at admission, with total bilirubin levels of 4.52 mg/dl, direct bilirubin levels of 3.52 mg/dl, lactate dehydrogenase (LDH) levels of 378 U/L, and gamma-glutamyltransferase (GGT) levels at 128 U/L. While the leucocyte count was found to be within normal limits (8.08 K/µL), the neutrophil ratio was found to be elevated (76.3%), and the lymphocyte ratio was found to be significantly reduced (8.78%). The hemoglobin level was recorded as low as 5.65 g/dl at admission but decreased to 3.5 g/dl after 22 hours. Prothrombin time-international normalized ratio (PTT-INR) was within normal limits of 1,18; consequently, an endoscopy and a colonoscopy were performed to reveal the bleeding focus.

A combination of upper and lower gastrointestinal endoscopy revealed the presence of oesophageal varices and portal gastropathy, but no active bleeding focus was detected. Subsequently, a decision was made to proceed with a comprehensive patient evaluation using contrast-enhanced upper and lower abdominal computed tomography (CT) and mesenteric CT angiography. CT angiography revealed multiple saccular aneurysms of varying sizes and structures along the splenic artery. In the distal part of the splenic artery, a saccular aneurysm with a diameter of 1 cm eroded the colon wall at the level of the splenic flexure and migrated to the sub-endometrial layer (**Figure 1**). Furthermore, late-phase imaging revealed the presence of hyperdense linear areas originating from the aforementioned aneurysm (**Figure 2**) and extending into the colon's lumen (**Figure 3**). Given the findings, which suggested the formation of a fistula between the splenic artery aneurysm and the colonic lumen at the level of the splenic flexure, the patient was referred to the interventional radiology department. It was decided that digital subtraction angiography (DSA) would be performed.

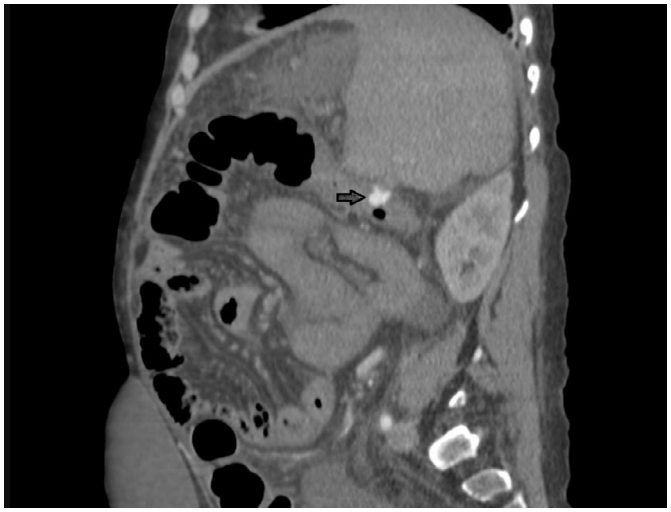

Figure 1. In the distal part of the splenic artery, a saccular aneurysm with a diameter of 1 cm eroded the colon wall at the level of the splenic flexure and migrated to the sub-endometrial layer (black arrow)

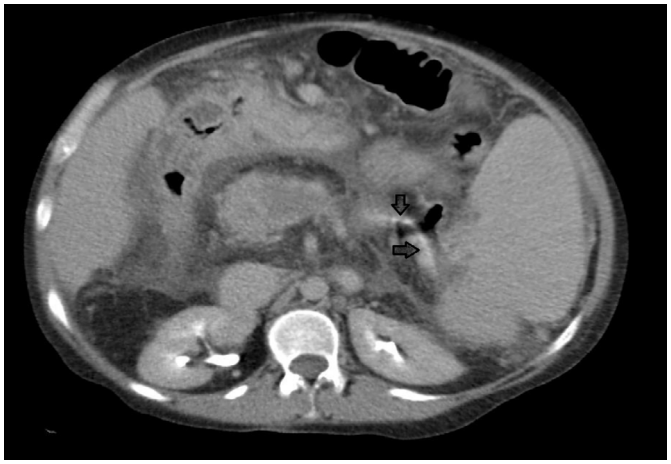

Figure 2. Late-phase imaging revealed the presence of hyperdense linear areas originating from the aforementioned aneurysm (black arrow)

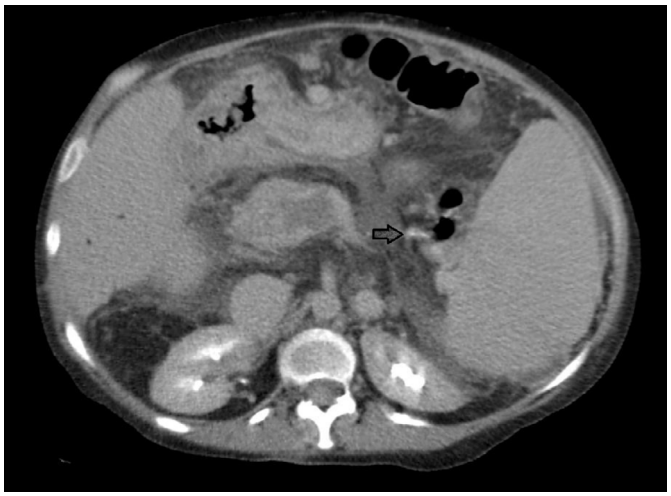

Figure 3. Extension of the hyperdense linear area into the colon lumen is shown (black arrow)

TREATMENT

Following the administration of local anesthesia, an 18G needle was inserted into the right common femoral artery under ultrasonography guidance, and a 5F 11 cm vascular sheath was placed. Selective catheterization of the celiac trunk was then performed using a 5F shepherd hook catheter and 180 cm hydrophilic glide wire, after which diagnostic DSA images of the celiac trunk and its branches were obtained. Following the confirmation of multiple aneurysms with various sizes and structures in the splenic artery (**Figure 4**), a microcatheter and microguide wire were used co-axially to reach the distal splenic artery and aneurysm localization was confirmed with contrast material (**Figure 5**). After reaching just proximal to the splenocolic fistula level with the microcatheter, the microcatheter lumen was washed with dextrose, n-acetyl cyanoacrylate with lipiodol was mixed 50/50, and a total of 10 cc was injected (**Figure 6**). Post-embolisation control DSA images revealed that the distal segment of the splenic artery and the aneurysms arising from this segment had been completely embolised, with no contrast agent visible (**Figure 7**). Subsequent dynamic CT images demonstrated that occlusion had been successfully achieved at the fistula level, with no evidence of transition to the colon lumen (**Figure 8**). Consequently, the procedure was terminated.

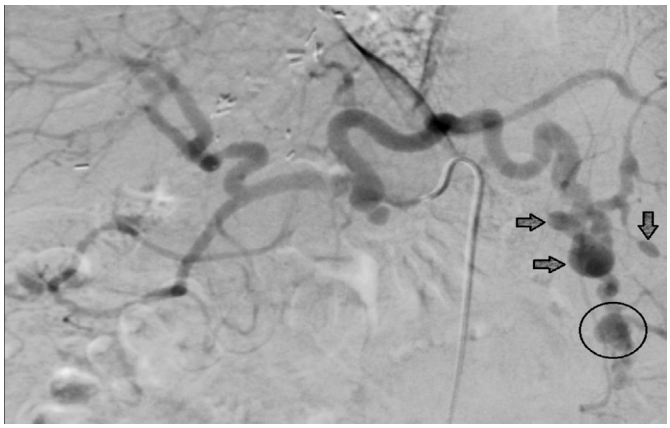

Figure 4. Multiple aneurysms of various sizes and structures are shown in the splenic artery (black arrow and black circle)

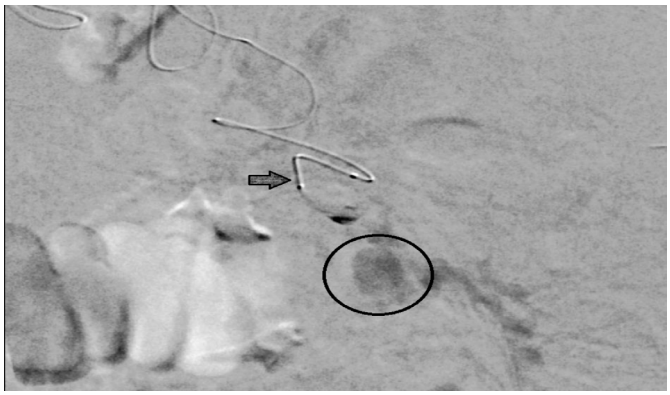

Figure 5. A microcatheter and microguide wire were used co-axially to reach the distal splenic artery and aneurysm localization was confirmed with contrast material (black arrow and black circle)

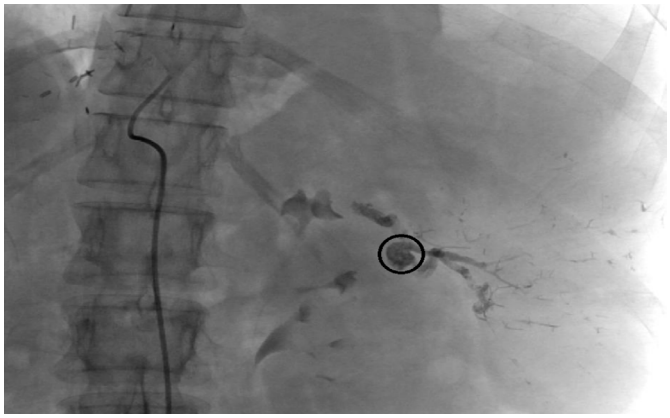

Figure 6. N-acetyl cyanoacrylate with lipiodol was mixed 50/50, and a total of 10 cc was injected (black circle)

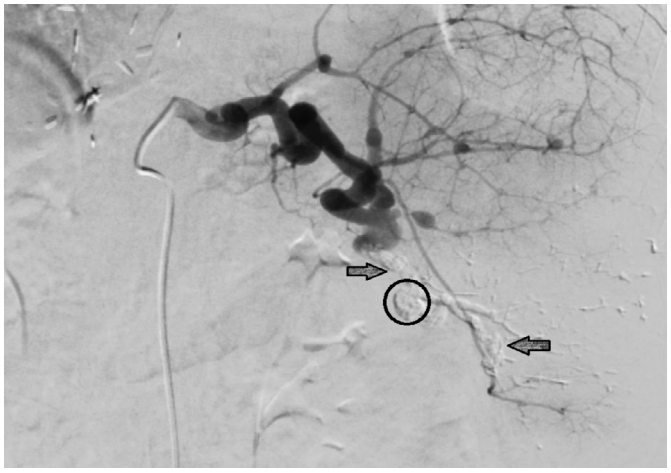

Figure 7. Post-embolisation control DSA images revealed that the distal segment of the splenic artery and the aneurysms arising from this segment had been completely embolised, with no contrast agent visible (black arrow and black circle)

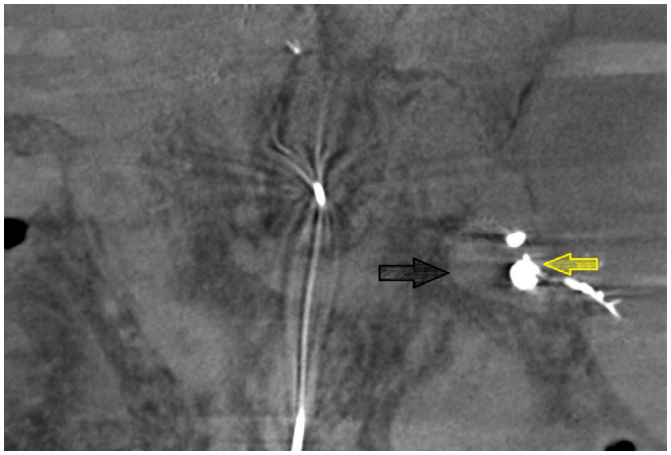

Figure 8. Occlusion had been successfully achieved at the fistula level, with no evidence of transition to the colon lumen (black arrow)

CONCLUSION

The patient became hemodynamically stable and the hemoglobin level increased to 7.55 mg/dl after 24 hours. The patient's complaint of melena disappeared, and no blood was observed in the colon's lumen during the control colonoscopy. Only yellow-brown fecal material was observed.

ETHICAL DECLARATIONS

Informed Consent

The patient signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Spinal meningitis and abscess associated with dermal sinus tract: a case report

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ABSTRACT

This case report discusses an 11-month-old male with a dermal sinus tract (DST) complicated by spinal meningitis and a long-segment intramedullary abscess. DSTs are rare congenital malformations that may remain asymptomatic until complicated by infections or neurological deficits. The patient was presented with prolonged fever and motor weakness in the extremities, leading to the discovery of a lumbosacral DST and associated abscess via cerebrospinal fluid (CSF) analysis and contrast-enhanced spinal MRI. Prompt surgical excision of the DST, drainage of the abscess, and prolonged antibiotic therapy resulted in significant clinical improvement. This case underscores the importance of early recognition, advanced imaging, and aggressive management to mitigate the severe neurological consequences of DST-associated infections.

Keywords: Dermal sinus tract, spinal meningitis, magnetic resonance imaging

INTRODUCTION

Dermal sinus tracts (DSTs) are rare congenital malformations that are caused by an incomplete separation of the neural ectoderm from the cutaneous ectoderm during embryogenesis. DSTs are epithelial-lined tracts that may extend between the skin and the spinal cord, cauda equina, or arachnoid.[1,2] While many DSTs are identified in infancy or early childhood due to skin manifestations, they may remain asymptomatic until complicated by infections or neurological deficits.[3]

Infection of the sinus tract can lead to serious complications such as meningitis, epidural-intradural or spinal cord abscess. These infections are a major cause of morbidity and hospitalization in the pediatric population.[4] Intramedullary spinal cord abscess is an extremely rare infection of the central nervous system, with fewer than 150 cases reported in the literature. These lesions most typically arise in the thoracic and lumbar spine in individuals with congenital midline defects or anatomical abnormalities.[5,6] Early diagnosis and rapid treatment are crucial to prevent potential neurological sequelae and mortality.[7]

In this case report, we aimed to present the clinical features and magnetic resonance imaging (MRI) findings of a pediatric case with DST and accompanying long segment spinal cord abscess.

CASE

The 11-month-old previously healthy male, born full-term via normal vaginal delivery with up-to-date vaccinations, presented to our clinic with a one-month history of daily fever peaking at 39°C, resolving with antipyretics. No associated symptoms were present. He had been hospitalized for 15 days at a tertiary hospital and treated with broad-spectrum antibiotics, followed by 3 days at another center with ampicillin-sulbactam. Blood and urine culture tests were negative. Immunological and infectious tests were negative for cytomegalovirus, Ebstein-Barr virus, and Brucella.

The patient was admitted to our clinic for further evaluation of prolonged fever. Blood and urine infection tests performed in our center were also negative. Abdominal ultrasonography and echocardiography were normal. Peripheral blood smear and bone marrow examination revealed no signs of leukemia or malignancy. Physical examination revealed significant loss of motor strength in both bilateral upper extremities (2/5) and lower extremities (1/5). Additionally, a midline located sacral dimple was noted. Other systemic examinations were unremarkable. Subsequently, the patient developed persistent fever, tachycardia, and further weakness in the upper extremities. Laboratory tests revealed an elevated

white blood cell count (14.000 cells/μL), increased C-reactive protein level (16 mg/dl) and anemia (Hb: 6.8 g/dl). Septicemia was suspected, and empiric meropenem antibiotherapy was promptly initiated.

Lumbar puncture performed to analyze cerebrospinal fluid (CSF). Additionaly contrast-enhanced spinal MRI was scheduled. CSF analysis indicated glucose levels of 0.94 mg/dl, protein levels of 1.57 g/L and a white blood cell count of 8560 mm^3 (90% neutrophils). CSF bacterial culture results showed a polymicrobial appearance, including gram-positive diplococci, gram-negative bacilli, and anaerobic organisms. On T2W and STIR MR images, there was a diffuse hyperintense signal consistent with myelitis throughout the entire spinal cord from the medulla oblongata to the level of the conus medullaris (**Figure 1a, b**). Sagittal contrast-enhanced T1W image showed leptomeningeal enhancement and peripherally enhancing interconnected fluid collections at the T7-S2 level (**Figure 1c**). These findings were consistent with spinal meningitis complicated by intramedullary abscess. Contrast-enhanced spinal MRI also revealed a possible appearance of a DST is noted posterior to the S1-2 vertebral level.

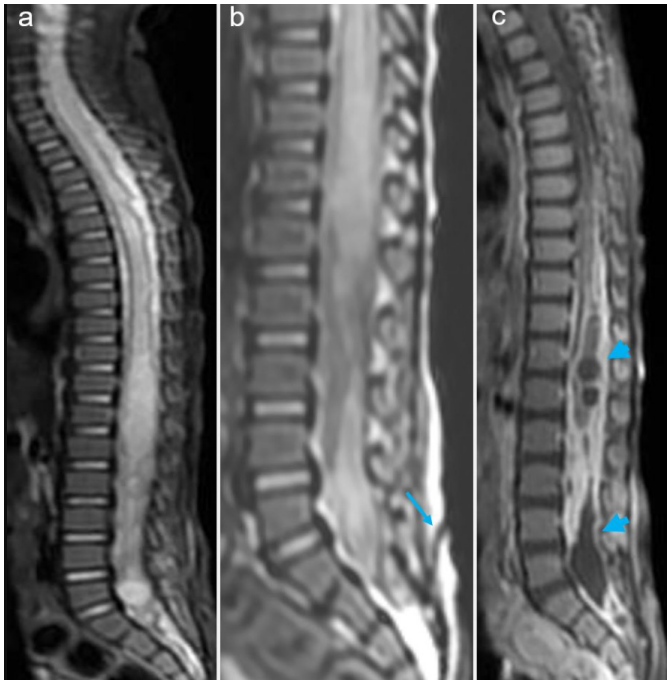

Figure 1. a, b. Sagittal T2-weighted and short tau inversion recovery (STIR) images show a diffuse signal increase and expansion in the spinal cord, consistent with myelitis. The sagittal T2-weighted image also demonstrates dermal sinus tract (long arrow) at the S1-S2 level. **c.** Sagittal contrast-enhanced T1-weighted image demonstrates interconnected fluid collections with rim enhancement within the spinal cord (arrowheads) and thick enhancement on dura between T7-S2 levels. This appearance is consistent with spinal meningitis and abscess.

The patient underwent surgery to remove the DST and drain the intramedullary abscess. Fistula tract was evident in the subcutaneous tissue entering the dural sac. There was a white, soft-consistency tumor tissue containing hair, resembling a dermoid tumor, in the intradural area at the L5-S1 vertebra level. The pathological diagnosis of this lesion was ruptured dermoid cyst. Following the surgery, the patient was monitored in the ward under broad-spectrum antibiotic therapy for three months and subsequently discharged. Follow-up contrast-enhanced spinal MRI revealed regression in the size and enhancement of the described collection and soft tissue areas.

DISCUSSION

DSTs are congenital malformations present at birth over the dorsal midline where an aberrant epithelialized connection from the skin tracks inwards towards the spine.[8] They are one of the types of spinal dysraphism and are observed in 1 in 2500 live births.[9,10] DSTs are predominantly located in the lumbosacral region. A 1990 review of all reported cases of congenital spinal DSTs indicated that 1% of the tracts were located in the cervical region, 10% in the thoracic region, 41% in the lumbar region, and 35% in the lumbosacral region. About 50% of DSTs are associated with inclusion tumors (epidermoid, dermoid, or teratoma) along their path and 83% of the accompanying tumors are dermoid cysts.[11] The DST in our case, like most cases in the literature, was located in the lumbosacral region, and a dermoid cyst accompanying this malformation was identified during surgery.

The most common clinical presentation of DSTs is a small dimple or sinus opening located in the midline of the skin. These skin findings may be accompanied by findings such as hyperpigmentation, hypertrichosis, and angiomata. Unlike coccygeal pits, which are frequently observed in the midline of newborns, these findings may be associated with occult spinal dysraphism and therefore require imaging of the spinal neuraxis.[1,8] About 30% of DST cases exhibit neurological deficits, such as lower limb weakness, sensory disturbances, altered reflexes, changes in bowel or bladder function, or gait abnormalities.[1,2] Since the tract terminates in the intradural space or around the spinal elements in approximately 80% of DSTs, a potential pathway for pediatric spinal infections is created. Infectious complications of DSTs such as abscess and meningitis were observed in half of the cases in some older studies.[11] However, they have been rarely reported in the modern era due to the increased awareness of primary care physicians regarding DST and early diagnosis with MRI.[1,3,12]

Spinal intramedullary abscess secondary to DST is a very rare but life-threatening condition with only 50 cases reported to date. Fever, lower extremity weakness and urinary disturbances are the most common presentations.[7,13,14] These lesions have been reported more frequently in children under 3 years of age. *Staphylococcus aureus* is the most commonly isolated microorganism, and multiple bacteria are grown in culture in one out of five cases of secondary spinal abscess to the DST.[13,15] In our case, similar to the literature, spinal abscess secondary to DST was detected in early childhood. In addition, the polymicrobial appearance in the bacterial culture of the case is striking.

MRI is the primary diagnostic tool for the diagnosis of both DSTs and complications such as meningitis and abscesses that develop secondary to these lesions. MRI can clearly reveal the location of the sinus tract and the termination area (dura, spinal cord) and provide detailed information about neural structures thanks to its excellent soft tissue resolution.[16] In addition, lesions such as inclusion cysts (dermoid, epidermoid), split cord malformation, and filum terminale lipoma that may accompany DSTs can be easily depicted on spinal MRI.[13,16] Spinal intramedullary abscesses are heterogeneously hypointense on T1W images and hyperintense on T2W images and show peripheral enhancement.[13] Spinal abscesses often spread along a long segment, as in our case, and rarely,

involvement of the entire spinal cord can be observed.[13,17] When the abscess is in the dural space and the cord covers a large area, the accompanying inclusion cysts may not be selected on MRI, as in our case.

The main treatment approach for intramedullary abscesses secondary to DST is excision of the sinus tract and drainage of the abscess. In addition, long-term postoperative antibiotic therapy is necessary to prevent the recurrence of residual infection.[13,15] Early diagnosis and prompt treatment are crucial to prevent permanent neurological deficit and potential morbidity and mortality.[15] The case we presented and the outcome of the cases in literature with prompt treatment highlight this view.

CONCLUSION

In conclusion, this case report highlights the critical importance of early recognition and management of DST-associated complications, including spinal meningitis and intramedullary abscesses. Prompt diagnosis using advanced imaging modalities and timely surgical and antibiotic interventions can significantly mitigate morbidity and prevent long-term neurological sequelae in such rare congenital malformations.

ETHICAL DECLARATIONS

Informed Consent

The patient signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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