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Evaluation of the relationship between prostate volume and prostate specific antigen in patients diagnosed with benign prostatic hyperplasia

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ABSTRACT

Aims: The aim of this study was to investigate the relationship between prostate volume and prostate specific antigen (PSA) levels in patients diagnosed with benign prostatic hyperplasia (BPH). In addition, it is aimed to show that BPH may be one of the causes of PSA elevation in patients without prostate cancer.

Methods: Prostate volume was calculated in 60 BPH patients who underwent prostate magnetic resonance imaging (MRI) imaging in radiology department between December 1, 2023 and March 1, 2024 due to elevated PSA. The relationship between prostate volume and the total prostate specific antigen and FPSA values of the patients in the last month was evaluated.

Results: There was a positive correlation between age and TPSA and in patients with benign prostatic hyperplasia. However, the correlation between age and FPSA was stronger. Similarly, a positive correlation was found between prostate volume and TPSA and FPSA. The correlation between increased prostate volume and increased FPSA was also stronger.

Conclusion: In our study, a positive correlation was found between prostate volume and TPSA and FPSA in patients diagnosed with BPH. It was determined that one of the reasons for the increase in PSA values may be the increase in prostate volume.

Keywords: Benign prostatic hyperplasia, prostate specific antigen, prostate volume, magnetic resonance

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a regional nodular growth affecting the transitional zone of the prostate gland. It is a common benign neoplastic condition affecting men. BPH accounts for 83% of prostate neoplasia cases. Several studies have reported that BPH is the most common prostate lesion, accounting for 63% to 83% of prostate diseases.[1-3] Studies have found evidence of prostatic hyperplasia in more than 80% of autopsies performed in men over 70 years of age. However, symptoms compatible with the disease were observed in 40% of men aged 50-64 years.[4]

Affected men and these symptoms are referred to as lower urinary tract symptoms (LUTS). BPH clinically results in LUTS and the cumulative risk for developing acute urinary retention increases with age.[5] Not all men with enlarged prostate have these symptoms. Only one in every ten men over 50 years of age has LUTS due to BPH.[6]

Prostate magnetic resonance imaging (MRI) and prostate specific antigen (PSA) measurement are widely used as screening tools to rule out prostate adenocarcinoma.[6]

PSA is a serine protease produced almost exclusively by epithelial cells of the prostate gland, and the normal total PSA(TPSA) level in cases of BPH is between 0 and 4 ng/ml.[7]

Serum PSA is thought to correlate well with prostate volume and it has also been suggested that high PSA levels predict BPH progression. It has been suggested that prostate volume is an important determinant of BPH progression and response to pharmacotherapy, which has become the mainstay of first-line treatment. A correlation has been found between TPSA level and prostate volume in men with histologically proven BPH, but the correlation between free PSA and prostate volume is stronger.[8] In a study conducted in Saudi Arabia in

men with a mean age of 64.2 years, prostate volume of 35.2 ml and TPSA of 2.2 ng/ml, a significant correlation was found between prostate volume and PSA.[9] In Jos, Nigeria, Udeh and colleagues studied 120 men with histologically proven BPH. In patients with a mean age of 65 years, prostate volume of 72.79 ml and TPSA of 12.44 ng/ml, a correlation was found between prostate volume and TPSA.[10]

The aim of this study was to investigate the relationship between prostate volume and PSA levels in patients diagnosed with BPH. In addition, it is aimed to show that BPH may be one of the causes of PSA elevation in patients without prostate cancer.

METHODS

This study was planned as a retrospective observational study in 60 patients with BPH who underwent prostate MR imaging due to elevated PSA in the radiology department between December 1, 2023 and March 1, 2024. This study was approved (Date: 26.03.2024, Decision No: 2024/191) by the local ethics committee of Selçuk University Faculty of Medicine. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The patients included in the study were imaged with an MR device with a magnetic power of 1.5 T in the radiology department of our hospital. In T2A images obtained in axial and coronal planes, a slice thickness of 3 mm was obtained without slice skipping and TE: 100 ms, TR: 6000 ms; voxel size: 3.0x3.0x3.0 mm; matrix 256x224; flip angle: variable; FOV: 200 mm. Isotropic images with high resolution were reconstructed in multiple plans and evaluated. Prostate volume was calculated from the prostate MR images of the patients by first determining the prostate borders and then using the volume calculation software (Figure).

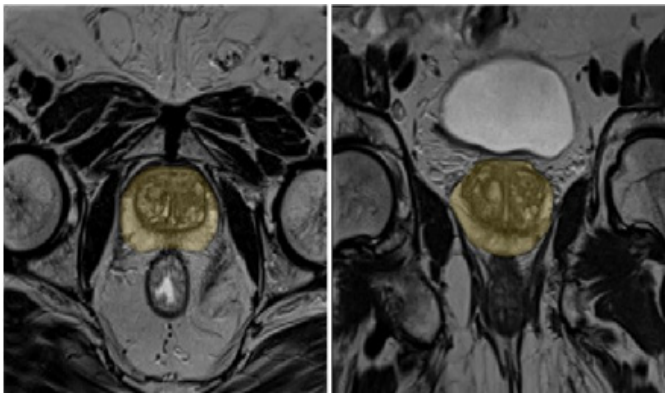

Figure: Prostate volume was calculate from axial and coronal MR images

At the same time, free prostate specific antigen(FPSA) and(TPSA) values of the patients in the last month were collected using the hospital database. Patients receiving prostate volume reduction therapy (5 alpha reductase inhibitors), patients with acute prostatitis and patients with histologically diagnosed prostate cancer were excluded from this study.

Pearson correlation test was used to analyze whether there was any correlation between prostate volume, patient age, FPSA and TPSA. Analyses were conducted using the Statistical Package for Social Sciences (SPSS) v.26.0 program. The results were evaluated at 95% confidence interval and significance was evaluated at $p<0.05$ level.

RESULTS

The prostates of a total of 60 BPH patients who underwent prostate MR imaging were evaluated. The mean age was 63.2 years and mean prostate volume was 70.7 ml (Table 1).

Table 1. Demografics of the patients.

	Mean	Std. Deviation	N
Prostate volume (mL)	70.7	30.4	60
Age	63.2	7.8	60
TPSA (ng/ml)	6.6	2.2	60
FPSA (ng/ml)	1.6	0.9	60

There was a positive correlation between age and TPSA and FPSA in patients with benign prostatic hyperplasia. However, the correlation between age and FPSA was stronger. Similarly, a positive correlation was found between prostate volume and TPSA and FPSA. The correlation between increased prostate volume and increased FPSA was also stronger (Table 2).

Table 2. Correlation between proostate volume and PSA values

	Prostate Volume	**TPSA**	**FPSA**	**Age**
Prostate Volume	1	.302**	.388**	0.204
		0,01	0,001	0,059
TPSA	.302**	1	.622**	.223*
	0,01		0	0.044
FPSA	.388**	.622**	1	.368**
	0.001	0		0.002
Age	0.204	.223*	.368**	1
	0.059	0.044	0.002	

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).
PSA: Prostat specific antigen
TPSA: Total prostate specific antigen
FPSA: Free prostate specific antigen

DISCUSSION

This study investigated the relationship between prostate volume and TPSA and FPSA in patients with BPH. A positive correlation was found between the increase in prostate volume and the increase in TPSA and FPSA. In addition, a positive correlation was also found between age and TPSA and FPSA. Both age and prostate volume correlated more strongly with FPSA than TPSA.

Mao Q. et al.[8] investigated the relationship between prostate volume and TPSA and FPSA in 268 patients. They found no significant relationship between age and TPSA and FPSA in patients with a mean age of 67 years and a mean prostate volume of 42 ml. However, they found a significant relationship between prostate volume and FPSA and TPSA. They also found that the relationship between prostate volume and FPSA was stronger. The relationship between prostate volume and FPSA was also investigated by dividing the patients into 4 groups according to their ages: <60, 60-69, 70-79 and >80. In patients <60 years of age, the correlation between prostate volume and FPSA was found to be stronger. Similarly,

a significant correlation was found between prostate volume and TPSA and FPSA in our study.

Contrary to Mao Q. et al.[8] also found a positive correlation between age and TPSA and FPSA in our study. This result was thought to be due to the difference between the age and prostate volume of the patients in the two studies.

Mosli H. et al.[9] investigated the relationship between prostate volume and TPSA in 447 BPH patients with a mean age of 67.2 years and a mean prostate volume of 35.2 ml. The mean TPSA value was 2.2 ng/ml and a positive correlation was found with prostate volume.

However, no significant correlation was found between age and PSA values. In our study, a positive correlation was found between prostate volume and PSA values similar to Mosli H. et al.[9] However, in contrast to this study, a positive correlation was also found between age and PSA values in our study. Since our study included patients who underwent prostate MRI due to elevated PSA, the mean TPSA values were found to be different in the two studies.

Aigbe E. et al.[11] investigated the relationship between prostate volume and TPSA and FPSA in 80 patients with BPH. The mean age of the patients was 68 years, mean prostate volume was 88 ml, mean TPSA was 5.5 ng/ml and mean FPSA was 2.1 ng/ml. They also found a moderate positive correlation between prostate volume and TPSA and FPSA. In our study, a positive correlation was found between prostate volume and PSA values similar to Aigbe E. et al.[11] The difference in mean prostate volume was thought to be due to the difference in the measurement method and the population in which the study was conducted.

Limitations

The first limitation of our study is the small number of patients. The second limitation is that the patient group was selected from patients presenting with elevated PSA and therefore patients with BPH with normal PSA values were not evaluated.

CONCLUSION

In our study, a positive correlation was found between prostate volume and TPSA and FPSA in patients diagnosed with BPH. It was determined that one of the reasons for the increase in PSA values may be the increase in prostate volume. It is thought that BPH should be kept in mind in the differential diagnosis along with malignancy in patients presenting with elevated PSA.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethics Committe of Selçuk University Faculty of Medicine (Date: 26.03.2024, Decision No: 2024/191).

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.

REFERENCES

1. Akang EE, Aligbe JU, Olisa EG. Prostatic tumours in Benin City, Nigeria. *West Afr J Med*. 1996;15(1):56-60.
2. Egan KB. The epidemiology of benign prostatic hyperplasia associated with lower urinary tract symptoms: prevalence and incident rates. *Urol Clin North Am*. 2016;43(3):289-297.
3. Nwafor CC, Keshinro OS, Abudu EK. A histopathological study of prostate lesions in Lagos, Nigeria: a private practice experience. *Niger Med J*. 2015;56(5):338-343.
4. Boyle P, Napalkov P. The epidemiology of benign prostatic hyperplasia and observations on concomitant hypertension. *Scand J Urol Nephrol Suppl*. 1995;168:7-12.
5. Roehrborn CG. The epidemiology of acute urinary retention in benign prostatic hyperplasia. *Rev Urol*. 2001;3(4):187-192.
6. Catalona W, Richie J, Ahmann FR, et al. Comparison of digital rectal examination and serum prostate specific antigen in the early detection of prostate cancer: results of a multicenter clinical trial of 6,630 men. *J Urol* 1994;151(5):1283-1290.
7. Nnabugwu II, Ugwumba FO, Enivwenae OA, Udeh EI, Otene CO, Nnabugwu CA. Serum total prostate-specific antigen values in men with symptomatic prostate enlargement in Nigeria: role in clinical decision-making. *Clin Intervent Aging*. 2015;10:89-93.
8. Mao Q, Zheng X, Jia X, et al. Relationships between total/free prostate-specific antigen and prostate volume in Chinese men with biopsy-proven benignprostatic hyperplasia. *Int Urol Nephrol*. 2009;41(4):761-766.
9. Mosli H, Abdel-Meguid TA. The relationship between prostate volume, Prostate-specific antigen and age in Saudi men with benign prostatic conditions. *Afr J Urol*. 2010;16(4):117-123.
10. Udeh E, Dakum N, Amu O, Ramyil V. Correlation between serum prostate specific antigen and prostate volume in Nigerian men with biopsy proven benign prostatic hyperplasia: a prospective study. *Internet J Urol*. 2009;7(2):10-5580.
11. Aigbe E, Irekpita E, Ogbetere FE, Alili UI. Correlation between prostate volume and prostate-specific antigen in Nigerian men with symptomatic histologically-diagnosed benign prostatic hyperplasia. *Nigerian J Clin Pract*. 2022;25(9):1523-1528.

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Original Article

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Comparison of ultrasonography findings and fine needle aspiration biopsy results in benign-malign differentiation of thyroid nodules

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ABSTRACT

Aims: The aim of this study was to compare the ultrasonography findings and cytology-histopathology findings of thyroid nodules undergoing a fine needle aspiration biopsy.

Methods: The records of patients with thyroid nodules who underwent a fine needle aspiration biopsy between January 2023 and February 2024 in the radiology clinic were retrospectively analyzed. Patients with malign, benign, and atypia of undetermined significance on pathology were evaluated. The correlation and concordance between ultrasonography, cytology, and histopathology findings were investigated.

Results: A total of 114 patients with biopsy pathology results of 75 (65.7%) benign, 21 (18.4%) malign, and 18 (15.7%) atypia of uncertain significance were evaluated. The study included 87 (76%) female and 27 (24%) male patients. The mean age of all patients was 53.04 years. There was no significant correlation between age, gender, nodule location, and pathology result. The presence of contour irregularity and microcalcification in the nodule was significant for malignancy ($p<0.001$).

Conclusion: Ultrasonography is an effective diagnostic method to differentiate between benign-malign thyroid neoplasms. Ultrasound-guided fine needle aspiration biopsy has a high diagnostic rate. It is helpful in determining the subsequent clinical management option for most patients.

Keywords: Biopsy, thyroid nodule, ultrasonography, microcalcification

INTRODUCTION

Thyroid diseases are among the most common diseases in our country and in the whole world. Thyroid nodules are space-occupying lesions that are distinguished from the adjacent thyroid parenchyma by imaging applications. Nodules have been found in 10-67% of the adult population by ultrasonography (US) and in more than 50% of thyroid glands in autopsy series.[1] Thyroid nodule are more common in women (4:1 F:M). The prevalence increases with decreased iodine intake.[2,3] Most nodules are asymptomatic, but when symptomatic, they may present with thyroid dysfunction or rarely with compression symptoms.[3] Detected nodules may be benign or malign. The prevalence of malignancy in thyroid nodules based on biopsy results is approximately 10%.[3]

Ultrasound is a highly effective and preferred method for evaluating the parenchyma of the thyroid gland, detecting tissue stiffness due to chronic diseases, and determining the characteristics of thyroid nodules.[4] After thyroid gland US, ultrasound-guided fine needle aspiration (FNA) biopsy is performed on the selected nodules.[5] Ultrasound-guided FNA of the thyroid refers to a minimally invasive procedure in which tissue samples are collected from a thyroid nodule or other suspicious thyroid lesion. It is usually performed rapidly in outpatients, and complications after this procedure are rare.[6,7]

In the literature, there are classification systems such as the Thyroid Image Reporting and Data System (TI-RADS)[8] that describe the findings of nodules suspicious for malignancy. There are many studies in the literature like our study conducted by different centers comparing thyroid nodule FNAB cytology-histopathology results with US findings.

The aim of this study was to compare ultrasonography findings with cytology-histopathology findings of thyroid nodules undergoing fine needle aspiration biopsy in our clinic.

METHODS

This retrospective study was conducted in accordance with the principles of the Declaration of Helsinki by performing a retrospective archive search of patients who underwent a fine needle biopsy of thyroid nodule tissue samples in our Radiology Unit between January 2023 and January 2024. The approval of the Kırıkkale University Faculty of Medicine Local Ethics Committee was obtained (Date: 20.03.2024, Decision No: 2024.03.10).

A total of 114 patients who were older than 18 years of age and whose fine needle thyroid nodule biopsy pathology results were reported as benign (75), malign (21), and atypia of uncertain significance (18) were included in the study. Three groups, including benign, malign, and atypia of uncertain significance, were compared with each other. Nodule size (<1.5cm, 1.5-2.5cm, >2.5cm), nodule location (left, right, isthmus), contour (regular, irregular), and presence of microcalcification (present or absent) were evaluated in the ultrasound report via the hospital information system. Demographic data on the patients was collected.

A thyroid biopsy was performed on a LOGIQ E9 (GE Healthcare, Wauwatosa, WI, USA) US system using high-resolution linear probes with a bandwidth of 6-15 MHz. A US-guided biopsy was performed with the patient in the supine position with the neck extended using 10 ml syringes with 22-Gauge fine needles (Figure 1, Figure 2). Biopsies were usually performed by sending the needle perpendicular or at a 45-degree angle to the transducer axis. During the procedure, the needle was moved back and forth in the nodule. The material obtained was sprayed onto slides and allowed to air dry. The slides were fixed to cardboard, and it was noted from which nodule the biopsies were taken. The slides fixed to the cardboard were sent to the pathology department of our hospital. The lobe and nodule from which the biopsy procedure was performed were recorded in the hospital data processing system. Biopsy materials were evaluated in the pathology laboratory of our hospital.

Figure 1. Thyroid USG with high resolution linear probes with 6-15 MHz bandwidth

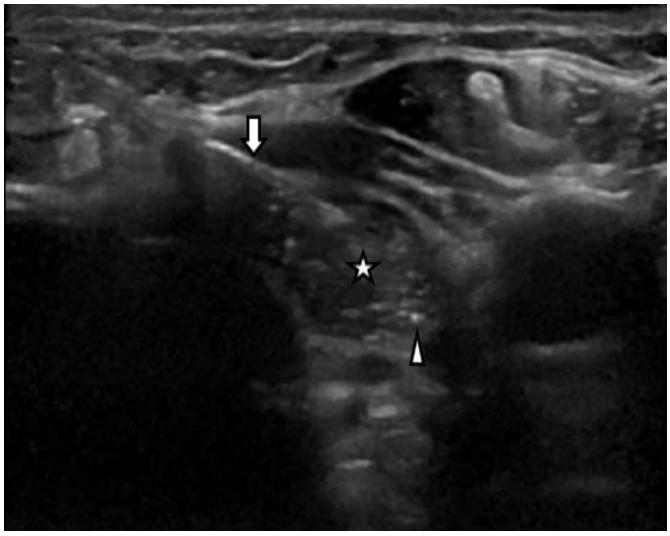

Figure 2. Fine needle aspiration biopsy (arrow) from a solid nodule (star) containing microcalcifications (triangle) in the left lobe of the thyroid gland

The IBM SPSS version 24 program was used for all statistical analyses. The Shapiro-Wilk test will be used to determine the normal distribution. Normally distributed descriptive values were expressed as mean and standard deviation, and non-normally distributed values were expressed as median (min-max). In two-group comparisons of continuous variables, normally distributed variables were compared by the t test, and non-normally distributed variables were compared by the Mann-Whitney U test. A chi-square test was applied in the comparison of categorical variables, and $p<0.05$ was considered significant.

RESULTS

A total of 114 patients with biopsy results of 75 (65.7%) benign, 21 (18.4%) malign, and 18 (15.7%) atypia of uncertain significance were evaluated. The study included 87 (76%) female and 27 (24%) male patients. The mean age of all patients was 53.04 years. Demographic characteristics of the patients and pathology results are given in Table 1. No significant correlation was found between age and gender variables and nodule pathology results.

Table 1. Patient characteristics and pathology result

Variables	Bening (n:75)	Malign (n:21)	Atypia of undetermined significance (n:18)
Age, mean ±SD	55.03 ± 14.1	48.43± 15.4	50.33± 13.1
Gender, n%			
Men	14 (12.3)	7(6.1)	6(5.2)
Women	61(53.6)	14(12.3)	12(10.5)

In our study, no significant correlation was found between the location of the nodule in the left lobe, right lobe, and isthmus and the pathology result of benign-malign-atypia of undetermined significance (AUS) ($p>0.05$). No significant correlation was found between nodule size (<1.5cm, 1.5-2.5 cm, >2.5cm) and the benign-malign pathology result, but in the distinction between malign-AUS, nodules reaching a size of 2.5 cm or more were found to be significant for malignancy ($p<0.001$).

When the nodule contour was evaluated, the presence of an irregular contour was found to be significant for malignancy

and AUS in the benign-malign distinction and in the benign-AUS distinction (p<0.001). No significant correlation was found between contour irregularity and the distinction of benign-malign atypia (p>0.05).

When the presence of microcalcification was evaluated, the presence of microcalcification in the nodule was significant for malignancy in the benign-malign and AUS-malign distinctions (p<0.001). No significant correlation was found between the presence of microcalcification and the distinction of AUS-benign (p>0.05).

Table 2. Nodul characteristics and pathology result

Variables	Benign (n:75)	Malign (n:21)	Atypia of undetermined significance (n:18)
Location, n(%)			
left	31(27.1)	11(9.6)	10(8.7)
right	36(31.5)	9(7.8)	8(7)
isthmus	8(7)	1(0.8)	0
Size, n(%)			
<1.5cm	28(24.5)	10(8.7)	4(3.5)
1.5-2.5 cm	28(24.5)	5(4.3)	13(11.4)
>2.5cm	19(16.6)	6(5.2)	1(0.8)
Contour, n(%)			
Regular	65(57)	8(7)	10(8.7)
Irregular	10(8.7)	13(11.4)	8(7)
Calcification, n(%)			
Yes	71(62.2)	13(11.4)	18(15.7)
No	4(3.5)	8(7)	0

DISCUSSION

The frequency of thyroid nodule diagnoses has increased with increasing imaging methods. Thyroid nodule fine needle biopsy has become one of the most common interventional procedures in many centers. There are many studies in the literature and classification systems such as TI-RADS in the selection of nodules for biopsy.[8,9] Papillary thyroid cancer and follicular thyroid cancer, the most common malign lesions of the thyroid, typically peak in the middle age group in the 3rd and 4th decades. The E:F ratio is 1:2.5 and is more common in women.[10] In our study, thyroid nodule diagnosis and hospital admission for biopsy were significantly higher in the female gender. However, no significant correlation was found between age and gender variables and nodule pathology results. The possible reason for this may be the small sample size.

Malhi et al.[11] biopsied 704 thyroid nodules with echogenic foci and 246 thyroid nodules without echogenic foci. They found that the prevalence of malignancy ranged from 15.4% to 19.5% for echogenic foci, excluding comet artifacts (3.9%). They found that all echogenic foci, except comet artifacts, were associated with cancer risk. In our study, similar to the study of Malhi et al.[11], the presence of microcalcifications was found to be significant for malignancy in benign-malign differentiation (p<0.001). Again, the presence of microcalcifications was found to be significant for malignancy in the malign-significant atypia distinction (p<0.001).

Cinar HG et al.[12] found that 50 of the nodules were benign (51.5%) and 47 were malign (48.5%) as a result of a biopsy of 97 thyroid nodules, of which 81 were female (83.5%) and 16 were male (16.5%). No significant relationship was found between the risk of malignancy and whether the nodule was a right or left lobe or isthmus. In our study, similar to the study of Cinar HG et al.[12], no significant correlation was found between the location of the nodule in the left lobe, right lobe, and isthmus and the pathology results of benign-malign-atypia of uncertain significance (p>0.05).

In the literature, there are many studies with different results on the relationship between nodule size and malignancy risk. The current approach is to use the ratio of the anteroposterior (AP) to the mediolateral (ML) size of the nodule.[13] Bestepe N et al. [14] compared the size and pathology results of 5561 thyroid nodules in 2463 patients and grouped the nodules as 540 (9.7%) <1 cm, 2413 (43.4%) 1-1.9 cm, 1600 (28.8%) 2-3.9 cm, and 1008 (18.1%) ≥4 cm. The malignancy rates for nodules less than 1 cm, 1-1.9 cm, 2-3.9 cm, and ≥4 cm were 25.6%, 10.6%, 9.7%, and 8.5%, respectively, and ROC curve analysis failed to identify an optimal cut-off value for diameter or volume to predict malignancy for all thyroid nodules or nodules larger than 4 cm. In this surgical series, the risk of malignancy did not increase with increasing nodule diameter or volume, and they concluded that the diameter or volume of the nodule cannot be used to predict malignancy or to decide on surgical resection. In our study, similar to the study by Bestepe N et al.[14], no significant correlation was found between nodule size (<1.5 cm, 1.5-2.5 cm, >2.5 cm) and benign-malign pathology results in the direction of malignancy, but nodules reaching a size of 2.5 cm or more were found to be significant in terms of malignancy in the differentiation of malign-insignificant atypia (p<0.001).

Chatti et al.[15] analyzed ultrasound data of 198 nodules (99 malign nodules and 99 benign nodules) in a single-center, retrospective study of 156 patients who underwent thyroidectomy. They found a strong association between thyroid nodule contour irregularity and malignancy (OR=7.47; p<10-3). In our study, similar to the study by Chatti et al.[15], the presence of an irregular contour was found to be significant for malignancy and AUS in the benign-malign distinction and in the benign-AUS distinction (p<0.001). No significant correlation was found between contour irregularity and the distinction of benign-malign atypia (p>0.05).

Limitations

There are several limitations in our study, the first of which is the small number of patients. Secondly, since the study was retrospective, thyroid ultrasound examination and fine needle biopsy were performed by different radiologists. This may have caused differences in biopsy technique, but in this single-center study, we tried to standardize the methods with dialogue and coordination between radiologists.

CONCLUSION

In recent years, with the increasing frequency of thyroid nodule diagnosis, the detection of suspected malign thyroid nodules with imaging devices has gained more importance. In the TI- RADS classification system, which groups thyroid nodules according to suspicion of malignancy, the presence of contour irregularity and microcalcification has been reported to increase the risk of malignancy in the nodule. In our study, it was found that the presence of contour irregularity and

microcalcification in the nodule similarly increased the risk. The detection of these features is a guide in determining the nodule to be biopsied.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Kırıkkale University Faculty of Medicine Clinical Researches Ethics Committee (Date: 20.03.2024, No: 2024.03.10).

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.

REFERENCES

1. Moon WJ, Jung SL, Lee JH, et al. Benign and malignant thyroid nodules: US differentiation--multicenter retrospective study. *Radiology*. 2008;247(3):762-770.
2. Xie C, Cox P, Taylor N, LaPorte S. Ultrasonography of thyroid nodules: a pictorial review. *Insights Imaging*. 2016;7(1):77-86. doi: 10.1007/s13244-015-0446-5
3. Popoveniuc G, Jonklaas J. Thyroid nodules. *Med Clin North Am*. 2012;96(2):329-349. doi: 10.1016/j.mcna.2012.02.002. PMID: 22443979. PMCID: PMC3575959.
4. Nachiappan A, Metwalli Z, Hailey B, Patel R, Ostrowski M, Wynne D. The thyroid: review of imaging features and biopsy techniques with radiologic-pathologic correlation. *Radiographics*. 2014;34(2):276-293. doi: 10.1148/rg.342135067
5. Haugen B, Alexander E, Bible K, et al. 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. *Thyroid*. 2016;26(1):1-133. doi: 10.1089/thy.2015.0020
6. Seiberling KA, Dutra JC, Gunn J. Ultrasound-guided fine needle aspiration biopsy of thyroid nodules performed in the office. *Laryngoscope*. 2008;118(2):228-231. doi: 10.1097/MLG.0b013e318157465d
7. Titton RL, Gervais DA, Boland GW, Maher MM, Mueller PR. Sonography and sonographically guided fine-needle aspiration biopsy of the thyroid gland: indications and techniques, pearls and pitfalls. *Am J Roentgenol*. 2003;181(1):267-271. doi: 10.2214/ajr.181.1.1810267
8. Tessler FN, Middleton WD, Grant EG, et al. ACR thyroid imaging, reporting and data system (TI-RADS): white paper of the ACR TI-RADS committee. *J Am Coll Radiol*. 2017;14(5):587-595. doi: 10.1016/j.jacr.2017.01.046. PMID: 28372962.
9. Grant EG, Tessler FN, Hoang JK, et al. Thyroid ultrasound reporting lexicon: white paper of the ACR thyroid imaging, reporting and data system (TIRADS) committee. *J Am Coll Radiol*. 2015;12(12):1272-1279. doi: 10.1016/j.jacr.2015.07.011. PMID: 26419308.
10. Takashima S, Sone S, Takayama F, et al. Papillary thyroid carcinoma: MR diagnosis of lymph node metastasis. *Am J Neuroradiol*. 1998;19(3):509-513.
11. Malhi H, Beland M, Cen S, et al. Echogenic foci in thyroid nodules: significance of posterior acoustic artifacts. *Am J Roentgenol*. 2014;203(6):1310-1316.
12. Cinar HG, Uner C, Kadirhan O, Aydin S. Thyroid malignancy in children: where does it locate? *Arch Endocrinol Metab*. 2023;67(4):e000603. doi: 10.20945/2359-3997000000603. PMID: 37252692. PMCID: PMC10665063.
13. Kim J, Lee C, Kim S, et al. Radiologic and pathologic findings of nonpalpable thyroid carcinomas detected by ultrasonography in a medical screening center. *J Ultrasound Med*. 2008;27(2):215-223.
14. Bestepe N, Ozdemir D, Baser H, Ogmen B, Sungu N, Kilic M, Ersoy R, Cakir B. Is thyroid nodule volume predictive for malignancy? *Arch Endocrinol Metab*. 2019;63(4):337-344. doi: 10.20945/2359-3997000000113. PMID: 30916163. PMCID: PMC10528648.
15. Chatti HA, Oueslati I, Azaiez A, et al. Diagnostic performance of the EU TI-RADS and ACR TI-RADS scoring systems in predicting thyroid malignancy. *Endocrinol Diabetes Metab*. 2023;6(4):e434. doi: 10.1002/edm2.434. PMID: 37327183. PMCID: PMC10335610.

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Review

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Knowledge level of the community and healtcare workers about radiological examinations and harmful effects of radiation: a review

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ABSTRACT

Patients, doctors, and radiology professionals are exposed to ionizing radiation in the diagnostic and therapeutic applications of radiology. Despite the proven harmful effects of medical radiological methods used for diagnosis and treatment, it is not possible to completely abandon these procedures.There is a lack of knowledge in the community about radiological examinations, the effects of radiation, and radiation protection. To increase awareness about radiation, it is essential to educate patients, enhance the education of healthcare students, and provide in-service training for all hospital staff. This way, knowledge levels can be improved, and the harmful effects of radiation can be minimized.

Keywords: Radiation, harmful effects of radiation, patient safety, knowledge level

INTRODUCTION

Patients, doctors, and radiology professionals are particularly exposed to ionizing radiation types such as gamma and X-rays in the applications of radiology for diagnosis and treatment.[1] In recent years, the increase in the number of hospital visits is attributed to easier access to healthcare facilities, the rise of chronic diseases due to aging, and an increase in the demand for medical treatment by patients. Consequently, there is an increase in radiological procedures for diagnosis and treatment. Although the harmful effects of medical radiological methods used for diagnosis and treatment have been proven, it is not possible to completely abandon these methods.[2]

Radiation and its Effects

Radiation has two types of adverse biological effects on living organisms, namely stochastic and deterministic.[3] Stochastic effects, although extremely rare, can manifest as a low risk of cancer even at low doses. However, the threshold dose for causing cancer in humans is unknown.[4-6] Stochastic effects occur with prolonged exposure to low doses of radiation. There is no threshold dose value, but the biological effect increases with the dose, while the effect intensity is independent of the dose. This can lead to the formation of leukemia, lung, gastrointestinal system, and thyroid cancers. Deterministic effects have a threshold dose value, and the effect increases proportionally with the dose. For certain dose levels in humans, effects ranging from blood and chromosome damage to sudden death can be clearly identified.[5-6] As a result of deterministic effects, delayed outcomes such as acute radiation syndrome, radiation burns, fibrosis, necrosis, and sclerosis may occur. These side effects vary depending on the dose and duration of exposure to radiation.

Devices Used in Radiology

There is a wide variety of devices used in radiology, operating on different mechanisms. Direct radiography, angiography, fluoroscopy, and computed tomography (CT) examinations are performed with ionizing radiation. Ultrasonography (USG) uses sound waves, and magnetic resonance imaging (MRI) is a non-ionizing radiation imaging method.[7]

Radiation Protection Methods

Radiation is commonly used in diagnostic and therapeutic procedures today. Controlled use of radiation is crucial for radiation safety during radiological examinations.

To protect healthcare personnel from ionizing radiation in examinations using ionizing radiation, exposure to radiation should be limited by minimizing time, maximizing distance, and using proper shielding.[8] Since the radiation dose decreases inversely with the square of the distance, it is essential to stay as far away as possible from radioactive sources. Additionally, the walls surrounding these environments should have sufficient concrete thickness and lead insulation. The use of lead aprons, lead gloves, lead injectors, lead glass, and shields should be ensured. Procedures should be avoided in unnecessary situations. Despite these precautions, raising awareness among healthcare workers and patients about examinations is crucial to minimize the harm from exposure to radiation.[9]

COMMUNITY KNOWLEDGE LEVEL

With advancements in healthcare technology, the use of ionizing radiation has increased in various diagnostic and treatment methods.[10] However, there is evidence indicating a low level of knowledge about these devices in the community.[11] Many studies on the subject have been conducted in our country. Most studies do not include all segments of society. While some studies included only healthcare professionals or subgroups, some studies included only the patient group. In our study, we evaluated the results of studies conducted with various groups in our country.

Device Information

In a study conducted with 949 patients by Ceylan et al.[12], it was found that 48.4% and 50.3% of patients were unaware of the presence of radiation in non-ionizing USG and MRI examinations, respectively. Moreover, a considerable portion of the group had no knowledge on the subject.

In a study by Yucel et al.[13], 20.5% of patients indicated that CT contains more X-rays than radiography, while 73.2% had no idea about the topic.

Koçyiğit et al.[3] found that about 20% of hospital staff had incorrect knowledge about examinations containing radiation. In the same study, assistant doctors stated that there is no radiation in USG and MRI methods at rates of 0% and 4.3%, respectively.[3]

According to Shiralkar et al.[6], 5% of doctors mentioned the presence of radiation in USG, and 8% in MRI.

Arslanoğlu et al.[14] found that 4% and 27.4% of participants in their study, including doctors with less than 10 years of experience, doctors with more than 10 years of experience, and 6th-year medical students, indicated the presence of radiation in USG and MRI, respectively. In the same study, 93% of doctors and intern doctors believed that the ionizing radiation dose patients are exposed to during radiological examinations is less than the actual dose.[14]

Cankorkmaz et al.[15], in their study with 4th-year medical students, found that 3.5% and 15.9% of participants mentioned the presence of radiation in US and MRI examinations, respectively, which they considered surprisingly low.

All studies indicate that the knowledge levels regarding USG and MRI, which do not involve ionizing radiation, are quite low among patients, students, non-medical healthcare professionals, and even doctors. When looking at knowledge levels, it is noteworthy that patients have the lowest knowledge level, followed by non-medical healthcare personnel, medical faculty students, and doctors.

Some doctors and interns believing that there is radiation in US and MRG can lead to misdirection during the request for tests. This can result in delays in the patient receiving a diagnosis and treatment. On the other hand, another group believes that the ionizing radiation dose in radiological examinations is less than the actual dose. In the study of Arslanoğlu et al.[14], doctors were asked to answer the ionizing radiation dose in radiological imaging methods in millisieverts (mSv) compared to chest radiography. In Koçyiğit et al.'s[3] study, it was asked how many chest radiographs corresponded to the ionizing radiation doses to which patients were exposed in radiological imaging methods. 64.9% of the assistant doctors stated that the abdominal CT, 79.4% in the barium stomach X-ray, and 58.8% in the abdominal X-ray contained less radiation. These rates are lower than in Arslanoğlu's[14] study. However, the fact that more than half of the assistant doctors think that the tests are at a lower dose than normal may lead to unnecessary and excessive requests for tests involving radiation.

Education Level

The higher knowledge level regarding radiation in physicians and assistants suggests that as the duration and intensity of education increase, the knowledge level also increases. Yücel et al.[13] and Sin et al.16 emphasized in their studies, conducted in 224 patients, that as the education level (primary school, secondary school, high school, and university) increases, the knowledge level about the harmful effects of radiation also increases.

Asefa et al.[17] conducted a study in southwest Ethiopia in 2016, indicating that in low-income and low-education countries, patients have insufficient knowledge about radiation and its effects. In studies conducted in Iraq, Nigeria and Uganda, the level of knowledge was even lower than this study.[18-20]

Information the Patients

The importance of informing becomes even more pronounced in situations where patients' knowledge levels are inadequate. In a study by Güdük et al.[11], 37% of patients expressed insufficient knowledge, indicating inadequate patient information. Koçyiğit et al.[3], in their study involving 250 participants, including resident physicians, medical school students, nurses, and administrative staff, found that 53% of participants stated that patients were not informed before medical imaging, and 13% had no idea whether patients were informed or not.

Larson et al.[21] investigated how the opinions of families about performing CT examinations for their children changed after receiving information about the risks of radiation. After a brief information session, it was observed that families

rejected the recommended examination in the face of the increased likelihood of cancer risk. When asked if frequent radiological examinations are harmful, 80.4% of participants (n:763) answered 'yes.' However, when asked how often the examinations were repeated, 45.8% of those who had X-ray examinations and 80.1% of those who had CT examinations (n:137) had the same examinations less than a year ago. Despite awareness of the harmful effects of radiation, the repetition rates are high. Reasons for this include inadequate questioning, patient request for re-examination, performance, incomplete examination records, and inappropriate shooting conditions.[12]

Busey et al.[9] concluded in their 2012 study that awareness of radiation dose increased when patients were informed. Baerlocher et al.[22] published a study involving patients applying to the interventional radiology unit, recommending mutual discussion and the use of visual and written methods. Al-Mallah et al.[23] conducted a study with 486 patients, emphasizing the need to inform patients before and during the imaging process using written, visual, or auditory instructions provided by technicians or other auxiliary healthcare workers.

The number of radiological examinations has increased by 50% from 2007 to 2017.24 This increase is attributed not only to technological advancements but also, as identified in the studies of Arslanoğlu et al.[14] and Cankorkmaz et al.[15], to the fact that doctors requesting the examinations perceive the radiation dose to which the patient is exposed as lower than it actually is. Not showing the necessary selectivity in the use of these devices leads to the emergence of new health risks.

Arslanoğlu et al.[14] suggested that if doctors requesting radiological examinations see the amount of radiation dose the patient will receive and its equivalence in terms of the number of chest X-rays in the request screen, they may change the prioritization and preferences of the examinations. This is an important suggestion, as the requesting doctor may abandon an examination that they do not believe is necessary for the diagnosis or prioritize a radiation-free examination that provides the same level of information.

Radiation Protection Methods

In radiological studies, the ALARA (As Low As Reasonably Achievable) principle dictates that the patient and radiology worker should receive the minimum dose.[25-27] This can be achieved by the doctor not requesting the examination unless necessary and the radiology worker protecting themselves and the patient using correct methods.[10] Protection from radiation is based on the three fundamental principles known as time, distance, and shielding. Shielding (lead block, lead apron, concrete block, etc.) is the most practical protection method used compulsorily in radiology clinics and hospitals. Distance is inversely proportional to the radiation dose. The farther away from the source, the lower the dose. Shortening the time spent in the device or environment where radiation is used also plays a significant role in radiation protection.[28]

Yıldırım et al.[10] reported that the knowledge level of radiology students about radiation protection principles was well below expectations. Slechta et al.[29] found an average knowledge score of 82.2 in their study with radiology technicians. Zhau et al.[30], in their study on medical students, found that students' average radiation knowledge was very low, with 6 out of 17 questions correct. Shabani et al.[31] found a knowledge score of 46 in their study on interventional radiology workers. Balsak, in a study with diagnostic radiology workers in 2014, obtained similar results, showing that radiation protection measures and the allowable annual dose specified by laws were generally unknown.[2] University students had a higher knowledge level about radiation and protection compared to high school students.[10] Yenal and Ergör's research on "occupational risk factors" targeted secondary school and university students. It was observed in this study that as the education level of students increased, their knowledge levels also increased.[32] The level of knowledge about radiation protection methods also increases with the level of education.

The most basic ways to protect against radiation in radiology units are wearing lead aprons and protective eyewear. In our study, it was found that particularly 32.1% of the students did not use lead aprons during fluoroscopy/portable radiography, and 93.8% did not wear protective eyewear. When questioned about the reasons for not wearing lead aprons during these procedures, responses included "I don't see the need," "it is not available in my department," "it is too heavy," "I believe distance provides sufficient protection," and "I don't use it because colleagues don't use it."[10]

Similar results were found in Balsak's study, where the prevalence of lead apron usage in the entire radiology unit was 51%, and protective eyewear usage was 14%.2 Slechta et al.[29] reported that only 31% of radiology technicians consistently wore protective aprons. In a study by Güden et al.[33], it was observed that 22.5% of radiology technicians wore lead aprons. Shabani et al.[31] found in their study on interventional radiology professionals that their attitude scores regarding radiation protection (use of lead aprons, protective eyewear, etc.) were 65 out of 100. Awosan et al.[34] (2016) reported a prevalence of 4.5% for the use of protective eyewear in their study with radiology professionals.

In a study by Helvacı[35], no difference was observed in the knowledge and attitudes of radiology professionals based on their school levels at graduation. Regarding attitudes, Holmström and Ahonen's[36] literature review on radiology student education revealed that students behaved like the professionals they worked with in practice, modeling themselves after radiology professionals who protected and supported them from unsafe practices. Despite the higher knowledge levels of vocational school students, they exhibited the same attitude as secondary education radiology students about radiation protection, supporting the view in Tilson's[37] study that personal safety practices do not differentiate with professional education.

Unnecessary radiological examinations increase radiation exposure for both patients and healthcare workers. Therefore, increasing radiation safety and education for medical faculties and healthcare workers will contribute significantly to reducing radiation exposure.14,[38] In a study by Çakmak et al.[28], 84.3% of medical students expressed the desire for

lessons on ionizing radiation and its hazards. Moreover, the majority of recommendations made on the Data Collection Form regarding this issue emphasized the need to increase radiation safety and education.[25]

Schuster et al.[39] reported in their studies that in recent years, patient's knowledge levels about radiation have increased. The reason for this increase was attributed to numerous studies on radiation safety and the provision of education to healthcare workers about ionizing radiation and its risks.

CONCLUSION

There is a lack of knowledge in society regarding radiological examinations, the effects of radiation, and radiation protection. As a result of this deficiency, both patients and healthcare workers are exposed to excessive radiation doses, unnecessary tests are conducted, and this process becomes a societal health issue.

To enhance the public's knowledge about radiation, it is essential to provide informative sessions for patients before and after diagnostic procedures. Additionally, increasing the number of courses on radiation and protection methods for radiology students at high school and university levels, as well as for medical students and residents, is crucial. Continuous and high-quality in-service training programs for all hospital staff are necessary. By implementing these measures, we can elevate knowledge levels and minimize the harmful effects of radiation.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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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.

REFERENCES

1. Osovets SV, Azizova TV, Day RD, Wald N, Moseeva MB. Direct and indirect tasks on assessment of dose and time distributions and thresholds of acute radiation exposure. *Healt Phys* 2012;102(2):182-195.
2. Balsak H. Radyoloji çalışanlarının tanı amaçlı kullanılan radyasyonun zararlı etkileri hakkında bilgi, tutum ve davranışları. Master's Thesis. İnönü University Institute of Health Sciences. 2014
3. Koçyiğit A, Kaya F, Çetin T, et al. Radyolojik tetkikler sırasında maruz kalınan radyasyon hakkında sağlık personelinin bilgi düzeyleri. *Pamukkale Tıp Derg.* 2014;7(2):137-142.
4. Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. *Proc Natl Acad Sci.* 2003;100(24):13761-13766.
5. Sont WN, Zielinski JM, Ashmore JP, et al. First analysis of cancer incidence and occupational radiation exposure based on the National Dose Registry of Canada. *Am J Epidemiol.* 2001;153(4):309-318.
6. Shiralkar S, Rennie A, Snow M, Galland RB, Lewis MH, Gower-Thomas K. Doctors' knowledge of radiation exposure: questionnaire study. *BMJ.* 2003;327(7411):371-372.
7. Kable VR, Mitra K, Ratnaparkhi C, Dhote S. Consultants knowledge and awareness about radiation exposure in diagnostic radiology in Central India. *Int J Biomed Res.* 2015;6(1):14-18.
8. Kirsch TD, Hsieh YH, Horana L, Holtzclaw SG, Silverman M, Chanmugam A. Computed tomography scan utilization in emergency departments: a multistate analysis. *J Emerg Med.* 2011;41(3):302-309.
9. Busey JM, Soine LA, Yager JR, Choi E, Shuman WP. Patient knowledge and understanding of radiation from diagnostic ımaging. *JAMA Intern Med.* 2013;173(3):239-241.
10. Yıldırım SA, Kurt B. Lise ve üniversite radyoloji öğrencilerinin radyasyon güvenliği hakkında bilgi düzeyleri ve tutumları. *Sağlık Akademisyenleri Derg.* 2018;5(4):311-317.
11. Güdük Ö, Kılıç CH, Güdük Ö. Radyasyonun zararlı etkileri hakkinda hastalarin bilgi düzeyinin değerlendirilmesi: bir hastane örneği. *Adıyaman* Üniv *Sağ Bil Derg.* 2018;4(2):874-889.
12. Ceylan I, Er A, Nayır T, Yaslı G, Akman C. Radyolojik tetkik yaptıran hastaların radyasyonun zararlı etkileri hakkında bilgi düzeylerinin araştırılması. *Smyrna Tıp Derg.* 2014;2:1-6.
13. Yucel A, Karakas E, Bulbul E, Kocar I, Duman B, Onur A. Knowledge about ıonizing radiation and radiation protection among patients awaiting radiological examinations: a crosssectional survey. *Med J Kocatepe.* 2009;10:25-31.
14. Arslanoğlu A, Bilgin S, Kubal Z, Ceyhan MN, Ilhan MN, Maral I. Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. *Diagn Interv Radiol* 2007;13(2):53-55.
15. Cankorkmaz L, Özşahin SL, Arslan MŞ, Gümüş C, Köylüoğlu G. Radyolojik görüntüleme yöntemlerinde hastaların maruz kaldığı iyonizan radyasyon dozu hakkında dönem IV tıp öğrencilerinin bilgi düzeyi. *Cumhuriyet Tıp Derg.* 2009;31(3):226-230.
16. Sin HK, Wong CS, Huang B, Yiu KL, Wong WL, Chu YC. Assessing local patients' knowledge and awareness of radiation dose and risks associated with medical imaging: a questionnaire study. *J Med Imaging Radiat Oncol.* 2013;57(1):38-44.
17. Asefa G, Getnet W, Tewelde T. Knowledge about radiation related health hazards and protective measures among patients waiting for radiologic imaging in Jimma University Hospital, Southwest Ethiopia. *Ethiop J Health Sci.* 2016;26(3):227-236.
18. Haider NA, IBMS F, MRD D. Patient's awareness of cancer risk from radiation in computerized tomography. *Kufa Med J.* 2011;14(1):166-172.
19. Malwadde EK, Matovu PD, Kawooya MG, Byanyima RK. Radiation safety awareness among radiation workers and clients at Mulago Hospital, Kampala, Uganda. East and Central African *J Surg.* 2006;11(1):49-51.
20. Margaret AK, Polycarp C, Valentine BP. Radiation safety awareness among patients and radiographers in three hospitals in Port Harcourt. *Am J Sci Ind Res.* 2013;4(1):83-88.
21. Larson DB, Rader SB, Forman HP, Fenton LZ. Informing parents about CT radiation exposure in children: It's OK to them. *AJR.* 2007;189(2):271-275.
22. Baerlocher MO, Asch MR, Puri G, Vellahottam A, Myers A, Andrews K. Awareness of interventional radiology among patients referred to the interventional radiology department: a survey of patients in a large Canadian community hospital. *J Vasc Interv Radiol.* 2007;18(5):633-637.
23. Al-Mallah A, Vaithinathan AG, Al-Sehlawi M, Al-Mannai M. Awareness and knowledge of ionizing radiation risks between prescribed and self-presenting patients for common diagnostic radiological procedures in Bahrain. *Oman Med J.* 2017;32(5):371-377.
24. United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and Efects of Ionizing Radiation Report to The General Assembly with Scientific Annexes Volume I. 2008:25-26.
25. International Commission on Radiological Protection (ICRP). ICRP Publication 103. *Ann ICRP.* 2007;37(2-4):2.
26. Gunderman RB. Temel Radyoloji. Nobel Yayınevi. 2003.
27. Integrated Environment Management Inc (IEM). The ALARA concept. Available from: http://www.iem-inc.com/information/radioactivitybasics/radiation-risks/the-alara-concept Accessed September 1, 2018.
28. Çakmak V, Çiğdem A, Koç M, Güngör B, Tuncel D. Pamukkale Üniversitesi Tıp Fakültesi öğrencilerinin tıbbi radyasyon ve radyasyon güvenliği hakkında bilgi düzeyleri. *Pamukkale Med J.* 2022;15(3):461-466.
29. Slechta AM, Reagan JT. An examination of factors related to radiation protection practices. *Rad Tech.* 2008;79(4):297-305.
30. Zhou GZ , Wong DD, Nguyen LK, Mendelson RM. Student and intern awareness of onizing radiation exposure from common diagnostic imaging procedures, *J Med Imaging Radiat Oncol.* 2010;54(1):17-23.
31. Shabani F, Hasanzadeh H, Emadi A, et al. Radiation protection knowledge , attitude and practice (KAP) in interventional radiology. *Oman Med J.* 2018;33(2):141-147.
32. Yenal S, Ergör A. Hastane öncesi acil bakım eğitiminde mesleksel risklerin yeri. *Acil Tıp Derg.* 2013;13(1):33-41.
33. Güden E, Öksüzkaya A, Balcı E, Tuna R, Borlu A, Çetinkara K. Radyoloji çalışanlarının radyasyon güvenliğine ilişkin bilgi tutum ve davranışları, *Sağlıkta Performans ve Kalite.* 2012;3(1):29-45.
34. Awosan KJ, Ibrahim MTO, Saidu SA, et al. Knowledge of radiation hazards radiation protection practices and clinical profile of health workers in a teaching hospital in Northern Nigeria. *J Clin Diagnost Res.* 2016;10(8):LC07-LC12.
35. Helvacı M. Edirne'de iyonlaştırıcı radyasyon kaynakları ile çalışan sağlık personelinin radyasyon güvenliği konusunda bilgi düzeyleri ve tutumları. Master's Thesis. Trakya University Institute of Health Sciences. 2011.
36. Holmström A, Ahonen SM. Radiography students' learnin: a literature review. *Radiolog Technol.* 2016;87(4):371-379.
37. Tilson E. Educational and experiental effects on radiographers radiation safety behaviour. *Radiolog Technol.* 1982;53(4):321-325.
38. Teferi S, Zewdeneh D, Bekele S. Pediatric residents' and medical interns' awareness about pediatric Ionizing radiation dose from computed tomography and Its associated risks in tertiary Hospital in Ethiopia. *Ethiop J Health Sci.* 2018;28(4):383-392.
39. Schuster AL, Forman HP, Strassle PD, Meyer LT, Connelly SV, Lee CI. Awareness of radiation risks from CT scans among patients and providers and obstacles for informed decision-making. *Emerg Radiol.* 2018;25(1):41-49.

Journal of Radiology Medicine in

Case Report

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Bullet lung injury in adolescent: a case report

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ABSTRACT

Gunshot injuries to adolescents involve a proportionate minority of the overall injury population. Especially thorax bullet injuries are even less common. This report aimed to express our experience by sharing the clinical process of our patient with this injury. A fourteen-year-old female patient was injured by a gunshot from a distance of approximately 10 meters while she was in the garden. It was understood that the bullet entry hole was from the scapular supraspinatus region towards the clavicle and the apex of the left lung. It was determined that the exit hole was in the hemithorax region below the left clavicle. The patient was admitted for follow-up and treatment. Since the patient's general condition was stable, after clinical follow-up, a thoracotomy was performed under elective conditions, intraparenchymal bone fragments were cleaned, and the left apical lobe was excised. Clinical follow-up is problem-free, and post-discharge follow-up is also problem-free.

Keywords: Bullet, thorax, children, surgery

INTRODUCTION

Penetrating traumas in children have increased to constitute 10-20% of child traumas worldwide.[1-4] Lung injuries caused by bullets in children occur mostly under war conditions.[1] In recent years, there has been an increase in child injuries caused by firearms in environments other than war conditions.[1] Among these, firearms add up to a significant part.[1] A study conducted in the USA determined that the financial loss resulting from workforce loss due to these types of injuries was approximately 48 billion dollars annually.[3]

The effect of the bullet varies. Mostly, emergency surgery is performed for those whose condition is unstable. If this effect does not disrupt the patients' stability, time can be gained to complete the appropriate preparations for surgery. Alternatively, in very selective situations, surgery may not even be performed on asymptomatic people because surgery may cost complications in perioperative or postoperative period.[1]

Contrary to popular belief, the "Wait-and-see" method can be used to monitor how the process is going, depending on the patient's stability.[1] We aimed to share our experience of lung injury with firearm. Although it is infrequent, we managed a patient like this with proper management for operation. We aimed to compare literature with our experience.

CASE

The fourteen-year-old female patient was injured by gunfire from a distance of approximately 10 meters while she was in the garden. She had no previous diseases or thoracal pathologies. It was understood in computerized tomography that the bullet entry hole was from the supraspinatus region on the scapula towards the clavicle through the apex of the left lung (Figure 1).

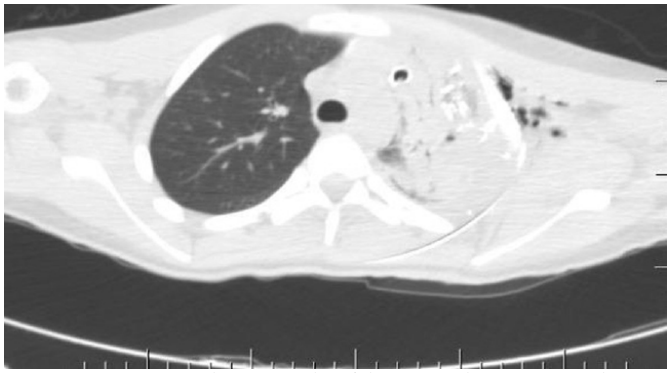

Figure 1: Computerized Tomography of the patient demonstrating the wounded parenchyma and fractured bone in it.

The apex was consolidated, and bone opacities could be seen in upper lobe of the lung. The exit hole is in the hemithorax region below the left clavicle. The patient was admitted for follow-up and treatment.

In her first examination, it was understood that his general condition was stable. Oxygen saturations were found between 93 and 97. A pleural drainage catheter was placed since hemopneumothorax was detected on the chest x-ray. Since approximately 400-600 cc of serohemorrhagic fluid was detected during the daily follow-up, the patient was followed for surgery with appropriate preparations as long as her general condition was stable.

Two days later, under elective conditions, a left lateral thoracotomy was performed by entering the fourth intercostal space. It was observed that the apex segment of the lung parenchyma was dissected almost completely (Figure 2).

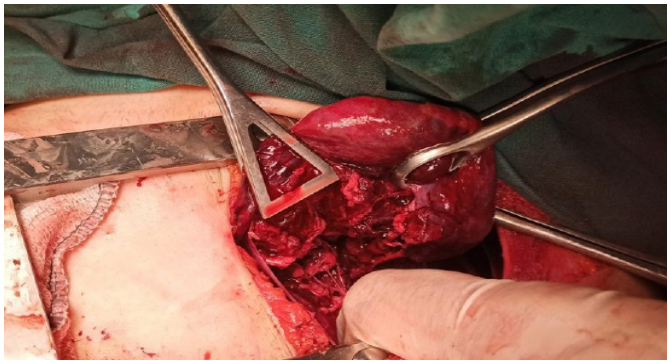

Figure 2: Perioperative illustration during the excision left lung apical segment

Excision was performed because there was tissue loss. In addition, it was determined that bone fragments found in the lung parenchyma were removed with an excised segment. A few small bone fragments in other adjacent segments were also excised during the manual evaluation, and the parenchyma was cleared of all bone fragments. When a double-row repair was performed to the lung, and it was observed that there was no leakage, the procedure was terminated by placing a pleural drainage catheter. As she had no complaints during the seven-day follow-up, the catheter was removed, and she was discharged. There were no additional problems during follow-up examinations. Control chest radiography showed deformed bone tissues and post-traumatic lung tissue (Figure3).

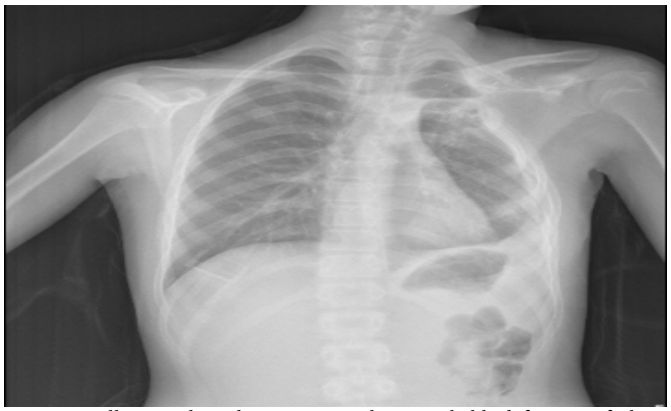

Figure 3: Follow up plain chest X-ray graph. Remarkable deformity of ribs and scapula can be detected

The patient did not come for a check-up because she had no complaints during phone communications for the last year.

DISCUSSION

Clinical treatments vary with foreign bodies, such as bullets penetrating the thorax.[2] Studies have shown that 90% of patients with penetrating trauma to the thorax die during or immediately after arrival at the hospital.[5] However, the impact of foreign bodies, such as bullets in the thorax, usually occurs when they affect the pleuroparenchymal functioning.[2] Radiologic findings contenting cardiac tamponade, right ventricular damage, and involvement in more than one area must be calculated as factors that increase mortality.[5] In these cases, urgent intervention is required, and delay in going to the operating room increases mortality.[2] Bleeding appears to be the most common cause of mortality in bullet injuries in children.[4] Mortality percentage can be expected to increase even more in combined body traumas.[4] Our patient did not have any liver or spleen injuries associated with lung injury. Computerized tomography showed clearly that only a part of left lung was affected.

The critical factor is determining where the affected area in the thorax is.[5] It is essential because the treatment will be planned according to the direction of the bullet.[5] In our patient left apical trauma with some bone fractures and without major vessel injury demonstrated obviously that there was no reason for clinical destabilization. There are some other factors that are important. The speed of the bullet determines the degree of damage.[1] In addition, the shock wave effect caused by the bullet, or its collateral effects depends on the angle of the bullet.[1] It should not be forgotten that faster action is needed in patients with problems such as spleen injury accompanied by multiple traumas.[4] Considering all these factors, it can be said that it is not easy to give a definitive opinion.[1]

In fact, consequences are not always dramatic. If the aforementioned factors are less destructive to parenchyma and vital functions, treatment strategy may be revisited. In the initial trauma evaluation, it is essential to decide whether the intervention will be made under emergency or appropriate conditions.[4] Work can be done to prepare appropriate conditions for a patient whose condition is stable.[4] Fortunately, our patient's condition was determined to be stable. Although there was bleeding, which was not surprising, the bleeding was slow and replaceable in 24-hour calculations; she was taken into surgery two days later to complete the examinations and blood preparation—no clinical problems or complications developed during this period.

CONCLUSION

In childhood thoracic injuries caused by gunshot, treatment might be tailored according to the patient's circumstances. Surgery can be performed in selective patients by arranging appropriate conditions or urgent surgery could be performed. To clarify which one will be preferred, not only clinical condition will be definitive, but also radiologic findings must be thoroughly understood. Radiologic evaluations

defining damages of cardiovascular system, respiratory insufficiency or contribution of other solid organs must be alerting for urgent operation. Most affective clinical factors determining whether the patient is selective are vital signs and hemorrhage. It is also necessary to carefully examine how the injury developed.

ETHICAL DECLARATIONS

Informed Consent

All patients signed and free and informed consent form.

Reviewer Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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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.

REFERENCES

1. Kandath MA, Pawar AA. An unusual case of prolonged intrapulmonary bullet impaction in a child and its successful extraction. *Lung India*. 2021;38(3):292-293.
2. Klein D, Pranay SM, Subrata KS, Nilesh G. Transthoracic migration of a foreign body into the diaphragm from the gunshot injury and its management in a child: a case report. *Surg J*. 2022;8(03):e224-e226.
3. Boeck MA,Strong B, Campbell A. Disparities in firearm injury: consequences of structural violence. *Curr Trauma Rep*. 2020;6(1):10-22. doi: 10.1007/s40719-020-00188-5
4. Elkbulia A, Menesesa E, Kinslowa K, McKenneya M, Boneva D. Successful management of gunshot wound to the chest resulting inmultiple intra-abdominal and thoracic injuries in a pediatric traumapatient: a case report and literature review. *Int J Surg Case Rep*. 2020;76:372-376.
5. Bolaji T, Ekpendu A C, Giberson F. Gunshot wound to the chest with retained epicardial bullet. *Cureus*. 2022;14(9):e29422. doi: 10.7759/cureus.29422

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Case Report

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A case of nonketotic hyperglycemia without movement anomalies: MRI findings

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ABSTRACT

In our case report, we aimed to describe a patient with nonketotic hyperglycemia who was admitted to the emergency department with left basal ganglion involvement presenting with a stroke-like picture without movement anomalies.

Keywords: Hyperglycemia, nonketotic hyperglycemia, MRI

This case report was presented as a printed poster at the 2016 Turkish Magnetic Resonance Society Ankara Congress.

INTRODUCTION

Diabetes mellitus (DM) can cause many neurologic complications such as peripheral neuropathy and encephalopathy. Nonketotic hyperglycemia (NKH) is a serious acute and mortal complication of uncontrolled DM. It is caused by hyperglycemia, hyperosmolality and dehydration due to uncontrolled diabetes.[1-3] Nonketotic hyperglycemic seizures present with high blood glucose levels, normal or increased serum osmolality and negative urine ketone bodies.[4] Rarely, focal seizure activity is also seen in patients.[5] The exact mechanism is still unknown. In this article, we present the clinical and radiologic features of a case diagnosed as nonketotic hyperglycemia.

CASE

A 69-year-old woman who presented to the emergency department with complaints of weakness and syncope had a history of diabetes and hypertension. She was receiving insulin and diuretic treatment. Biochemistry tests revealed a blood glucose level of 714 mg/dl (normal blood glucose levels: 60-109 mg/dl). Urinalysis was ketone negative. Brain CT scan of the patient with stroke symptoms showed hyperdansite in the left basal ganglion (Figure 1). Brain MRI was then performed. Brain MRI showed hypointensity in FLAIR and T2 A series (Figure 2,3), hyperintensity in T1 A series (Figure 4), minimal contrast enhancement (Figure 5) and diffusion restriction (Figure 6a and b) in the left thalamus and lentiform nucleus. The case was treated as nonketotic hyperglycemia.

The patient was discharged after a few days with resolution of symptoms. One month later, basal ganglia were normalized on brain CT.

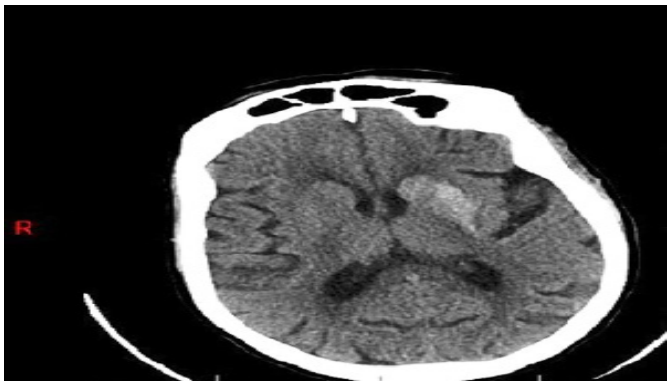

Figure 1. Hyperdensity at the level of the left basal ganglia on brain CT

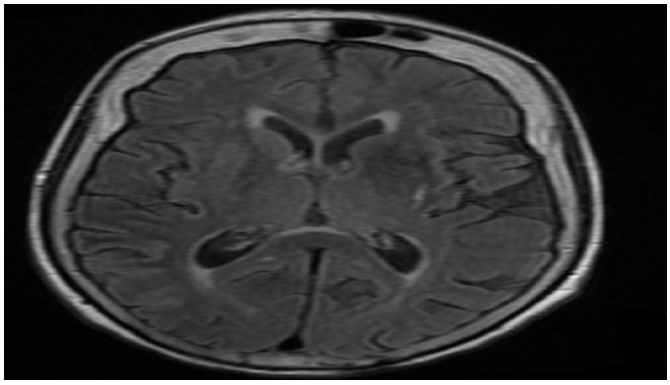

Figure 2. In MRI, hypointensity in FLAIR series in the same area

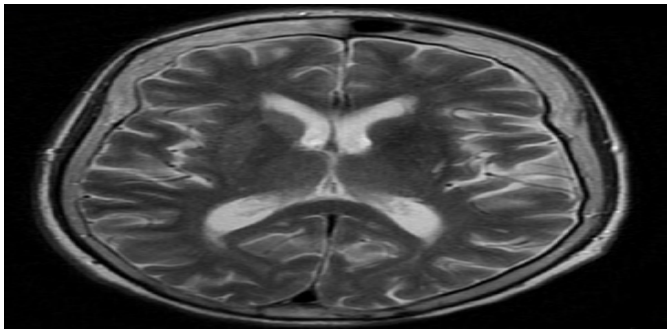

Figure 3. Hypointensity in T2A series

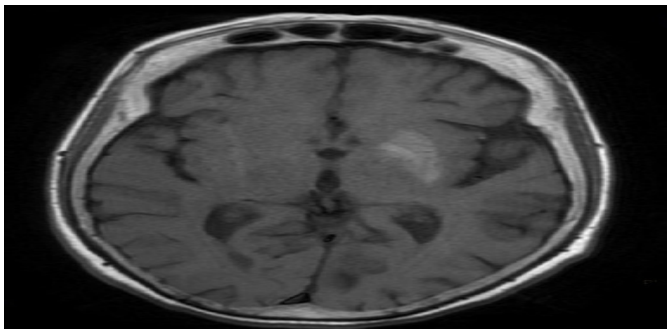

Figure 4. Hyperintensity in T1 A series

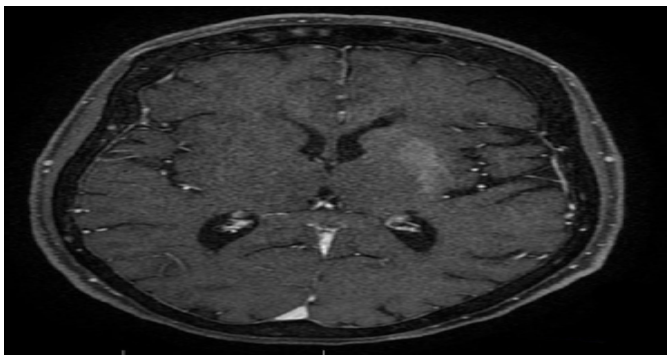

Figure 5. Minimal hyperintensity in contrast-enhanced series

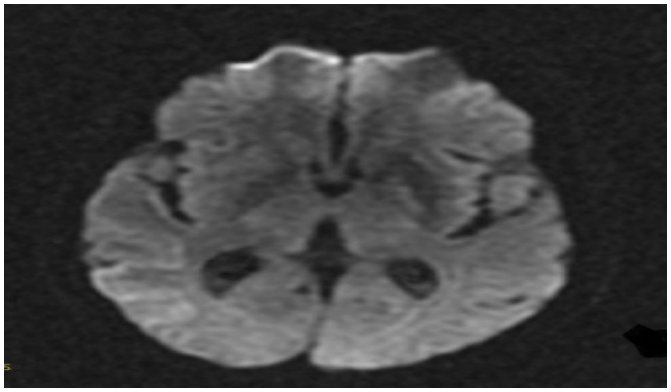

Figure 6 a. There is diffusion restriction in diffusion weighted series

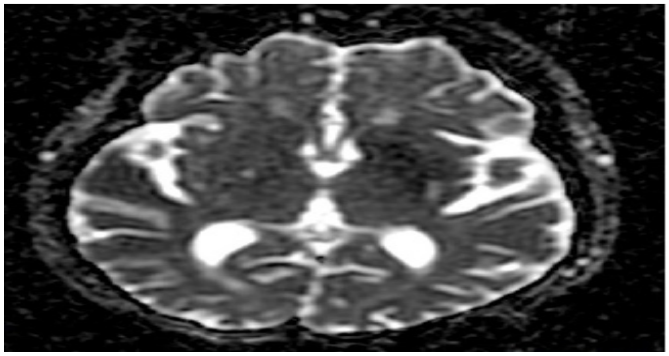

Figure 6 b. Diffusion restriction exists in diffusion weighted series(ADC)

DISCUSSION

Nonketotic hyperglycemia is a complication of DM that cannot be controlled with treatment, and its mechanism and imaging features are still a mystery. There are many different opinions in the literature. On magnetic resonance imaging, T2/FLAIR hypointensity in the subcortical posterior cerebral region is the most characteristic finding.[6] The most commonly reported MR imaging features of seizures associated with NKD are cortical hyperintensity and reversible subcortical hypointensity which may show restriction on diffusion-weighted images. The mechanisms that may cause these findings are reported to be focal cytotoxic edema secondary to cortical focal ischemia or hyperviscosity caused by free radicals and their units.[7,8]

It may also occur with single or bilateral basal ganglion involvement.[5] Hyperintensities of T1-weighted series observed in the basal ganglion are generally thought to be related to petechial hemorrhages.[9] In some series, it has also been suggested that this may be related to demyelination observed in diabetic patients.[10] The follow-up of T2 images and contrast-enhanced series varies in the literature.

Iwata et al.[11] showed contrast enhancement in the globus pallidus. It has been reported that hyperintensity may be seen in the basal ganglia region and most commonly in the putamen, then in the caudate and globus pallidus on T1-weighted images on MRI, whereas T2-weighted images may vary.[12,13]

In patients with unilateral or bilateral basal ganglion involvement, nonketotic hyperglycemia should be kept in mind in the differential diagnosis and questioning of the patient's history and laboratory values should not be neglected.

CONCLUSION

Pathologies other than infarction should be considered in the differential diagnosis of diffusion restriction observed in patients presenting to the emergency room with a stroke-like picture. Basal ganglion involvement may occur in nonketotic hyperglycemia without movement anomalies. Nonketotic hyperglycemia should be kept in mind as a differential diagnosis in patients with uncontrolled diabetes.

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.

REFERENCES

1. Tiamkao S, Pratipanawatr T, Tiamkao S, Nitinavakarn B, Chotmongkol V, Jitpimolmard S. Seizures in nonketotic hyperglycemia. *Seizure*. 2003;12(6):409-410. 10.1016/s1059-1311(02)00353-9
2. Maccario M: Neurological dysfunction associated with nonketotic hyperglycemia. *Arch Neurol*. 1968; 19(5):525-534. Doi: 10.1001/archneur.1968.00480050095009
3. Gorijala V, Shaik L, Kowtha P, et al. A case report of nonketotic hyperglycemic seizures: a diagnostic dilemma. *Cureus*. 2020;12(11): e11416. Doi: 10.7759/cureus.11416
4. Wang X. Nonketotic hyperglycemia-related epileptic seizures. *Chin Neurosurg*. 2017;3:16. Doi: 10.1186/ s41016-017-0073-8
5. Lai PH, Tien RD, Chang MH, et al. Chorea-ballismus with nonketotic hyperglycemia in primary diabetes mellitus. *AJNR Am J Neuroradiol*. 1996;17(6):1057-1064.
6. De Martino SRM, Toni F, Spinardi L, Cirillo L. Magnetic resonance imaging findings in patients with non-ketotic hyperglycaemia and focal seizures. *Neuroradiol J*. 2020;33(5):416-423
7. Lee EJ, Kim KK, Lee EK, Lee JE. Characteristic MRI findings in hyperglycaemia-induced seizures: diagnostic value of contrast-enhanced fluid attenuated inversion recovery imaging. *Clin Radiol*. 2016; 71(12):1240-1247.
8. Sekar S, Vinayagamani S, Thomas B, Kesavadas C. Arterial spin labeling hyperperfusion in seizures associated with non-ketotic hyperglycaemia: is it merely a post-ictal phenomenon? *Neurol Sci*. 2021;42: 739-744.
9. Shan DE, Ho DM, Chang C, et al. Hemichorea-hemiballism: an explanation for MR signal changes. *AJNR Am J Neuroradiol*. 1998;19(5):863-870.
10. Nagai C, Kato T, Katagiri T, Sasaki H. Hyperintense putamen on T1-weighted MR images in a case of chorea with hyperglycemia. *AJNR Am J Neuroradiol*. 1995;16(6):1243-1246.
11. Iwata A, Koike F, Arasaki K, Tamaki M. Blood brain barrier destruction in hyperglycemic chorea in a patient with poorly controlled diabetes. *J Neurol Sci*. 1999;163(1):90-93
12. Pan Y, Chew F, Wang R, Yin X, Li Y. Bilateral striatum with high-signal intensity on T1-weighted MRI: A case of hemichorea induced by nonketotic hyperglycemia. *Radiol Case Rep*. 2021;16(4):895-898.
13. Xu Y, Shi Q, Yue Y, Yan C. Clinical and imaging features of diabetic striatopathy: report of 6 cases and literature review. *Neurol Sci*. 2022;43(10):6067-6077.