Journal of Imaging Science for Diagnosis
Vol. 2 No.6 (2026): June 2026 issue
https://doi.org/10.51168/xr1bhb36
Case Report

Appropriateness of lumbar spine x-rays performed among children and young adults at Mengo Hospital: A Cross-Sectional Study

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ABSTRACT

Background:

There is limited information regarding the appropriateness levels for Lumbar spine X-rays (LSX) imaging among children (2-17 years) and young adults (18-35 years) with non-traumatic Lower back pain (LBP) in Ugandan Hospitals.

Objective:

To describe the appropriateness and findings of LSX imaging among children and young adults with non-traumatic LBP at Mengo Hospital

Methodology:

This was a cross-sectional study of 294 records that belonged to children and young adults. The LSX images were re-interpreted for findings. The disagreement in the interpretation was resolved by providing the same image to a more experienced Radiologist whose interpretation was used as a decision. The investigator relied on the American College of Radiology (ACR) appropriateness criteria for LBP imaging as a reference for determining appropriateness level for LSX imaging.

Results:

The 51.7% of the records belonged to females. The 31% of the patients' requests lacked information on the duration of LBP, radiculopathy, and red flag signs. The 65.7% of the LSX examinations were regarded as usually not appropriate, 3.7% were regarded; may be appropriate, and the rest had inadequate information to be judged for appropriateness level. The 65% of all patients had abnormal radiographic findings, with the commonest abnormal radiographic finding being lumbar straightening.

Conclusion:

About two-thirds of the LSX examinations performed among children and young adults with non-traumatic LBP at Mengo Hospital were deemed inappropriate. LSX findings of serious underlying pathologies were very rare among Children and young adults.

Recommendation:

Lumbar spine x-rays are not necessary in the majority of children and young adults with non-traumatic LBP at Mengo Hospital.

Keywords: *lumbar spine x-rays, children and young adults, Mengo Hospital*
Submitted: March 13,2026 Accepted: April 30,2026 Published: June 26,2026
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INTRODUCTION

Clinical evaluation based on signs, symptoms, and medical history is of low accuracy in ascertaining the causes of low back pain. (Cook et al., 2020; Mathieu et al., 2023), leading to reliance on medical imaging modalities in the form of Lumbo-sacral X-rays (LSX), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) to diagnose the causes of LBP (Al-hihi et al., 2022; Lemmers et al., 2019; Pakpoor et al., 2019). In Comparison with CT and MRI, LSX is the most commonly available and cost-friendly imaging modality in low and middle-income countries for the diagnosis of lumbar spine abnormalities. (Demetriades et al., 2022).

Despite the fact that inappropriate use of imaging is potentially harmful and resource-wasting (Kim et al., 2019), improper use without justification in the diagnosis/management of LBP has been found to be common (Liu et al., 2018). In developed Countries,

inappropriate use of imaging for LBP has been estimated at 4.3-34.8% (Jenkins et al., 2018; Traeger et al., 2021). In low and middle-income countries, overutilization of imaging in LBP has been estimated to be at 12-62% (Protheroe, 2024). Inappropriate levels of LSX imaging among LBP patients in the West African Country, Cameroon, have been estimated at 48.69% (Roger et al., 2022). In Uganda, although the study determining the appropriateness of use of LSX imaging is not available, inappropriate use of imaging investigations has been observed. In a retrospective cross-sectional study carried out across Ugandan CT facilities, it was reported that 34% of CT examinations performed among pediatric patients and young adults were inappropriate. (Kisembo et al., 2023). The availability of evidence-based guidelines, like the American College of Radiology (ACR) appropriateness criteria, can be used as an objective reference for defining appropriateness for LSX. (Hutchins et al., 2021), found to be applicable in several diverse settings (Tay et al., 2023; Xuan et al., 2023). This provides an opportunity to determine the appropriateness of LSX performed among children (2-17 years) and young adults (18-35 years) in Ugandan Hospitals.

Therefore, in order to contribute to the literature regarding the burden of inappropriate imaging in low-resource settings, this study was carried out. The primary objective is to determine the appropriateness levels and findings of LSX imaging performed among Children and young adults with non-traumatic LBP who attended a Ugandan Hospital.

METHODS

Study design

This was a cross-sectional descriptive study conducted among children and young adults presenting with LBP at Mengo Hospital.

Study setting

This study was carried out at Ernest Cook University (ECU) radiology department, a provider of Computed Radiography services to Mengo Hospital, Kampala, Uganda. The department is equipped with only 1 computed radiography machine, which was used to perform all LSX images.

Study population

The study population included all records of children (2-17 years) and young adults (18-35 years) who had undergone LSX imaging due to non-traumatic LBP between June 2023 and June 2024.

Sampling procedure

A consecutive sampling technique was employed to obtain the records for all children and young adults who underwent LSX due to non-traumatic LBP.

Inclusion criteria

All records of children and young adults who underwent LSX due to non-traumatic LBP were included.

Exclusion criteria

Records that indicated a positive history of spinal surgery in the last 6 months and those that do not mention imaging investigation(s) requested, clinical indication, age, sex, and two LSX views (antero-posterior and lateral) were excluded.

Sampling size

All consecutive request forms and their corresponding LSX images that belonged to children and young adults who underwent LSX imaging due to non-traumatic LBP from 1st June 2023 to 31st June 2024 were recruited in the study. Using the formula for the estimation of sample size for outcomes expressed as proportions (Monti et al., 2024), assuming the prevalence of inappropriate imaging at 49% as estimated by Rogers et al (Roger et al., 2022), Z score of 1.96 at 95% confidence interval and acceptable degree of error of 5%, the sample size was determined to be 384.

Data collection procedure

With the help of two research assistants, information technology personnel, and a medical imaging technologist, records of the patients who underwent LSX were searched from the ECU electronic medical records system. The search words used were: back pain, lower back pain, lumbar pains, spine, lumbar spine, lumbo-sacral spine, lumbar X-ray, lumbar radiography, and adults, as well as Children and Pediatrics. All the request forms and their corresponding LSX images retrieved were assessed for eligibility by the investigator. The investigator is using a pre-designed data abstraction tool. The data collected from request forms were: age, gender, duration of LBP, previous LBP medical history, presence of radiculopathy, and presence of red flags - referred to clinical signs and symptoms stated in the ACR guideline that are suspicious for serious underlying spine abnormalities.

The investigator assessed the appropriateness levels of request forms while using the ACR appropriateness criteria. The ACR appropriateness uses an ordinal scale where the lowest score is 1, and the highest score is 9, with a score of 1 indicating the exam is most likely inappropriate and a score of 9 indicating the exam is most likely appropriate. The guideline further compresses this ordinal scale to three hierarchical appropriateness levels; Level 1 entailing a score of 1-3, termed as “usually not appropriate,” Level 2, encompassing scores 4-6, regarded as “may be appropriate,”

Journal of Imaging Science for Diagnosis
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Case Report

and then Level 3, where scores 7-9 are regarded as "usually appropriate." The investigator also introduced two other categories: "cannot be assessed for appropriateness using ACR appropriateness criteria due to inadequate information" for records where information on red flags, radiculopathy, and duration of LBP were not provided on request forms. The other category was called "beyond the scope of the guideline" for LSX records whose scenario is not covered by the ACR appropriateness criteria.

LSX images were independently interpreted by two Radiologists, A and B, with experience of 2 years. In cases where the Radiologist A disagreed with Radiologist B in LSX findings, the LSX of records in contention were presented to a consultant Radiologist with experience of more than 10 years, blinded from the interpretation of Radiologist A and B, for decisive interpretation. The LSX radiologic findings were then recorded in the data abstraction form. The decision to re-interpret images was based on the difficulty of retrieving the reports for LSX images. The data from the abstraction form was entered into an Excel sheet and stored in a password-secured file on the computer of the investigator. The files filled with data were backed up on the Google Drive, which was only accessible to the investigator.

Data analysis

For statistical analyses, Statistical Package for the Social Sciences (SPSS) software (IBM SPSS software version 23) was used. Based on the information provided on the duration of LBP, radiculopathy, red flag signs, and previous medical history on the request form, the appropriate score was given. The percentages were calculated to determine the appropriateness levels. Radiographic findings were classified as either normal or abnormal. Using Frequencies and percentages, results were presented. Using binary logistic regression, with a significance level defined as a P-value less than 0.05, data were analyzed to determine whether there were significant differences in rates of abnormal findings for different appropriateness levels.

Ethical considerations

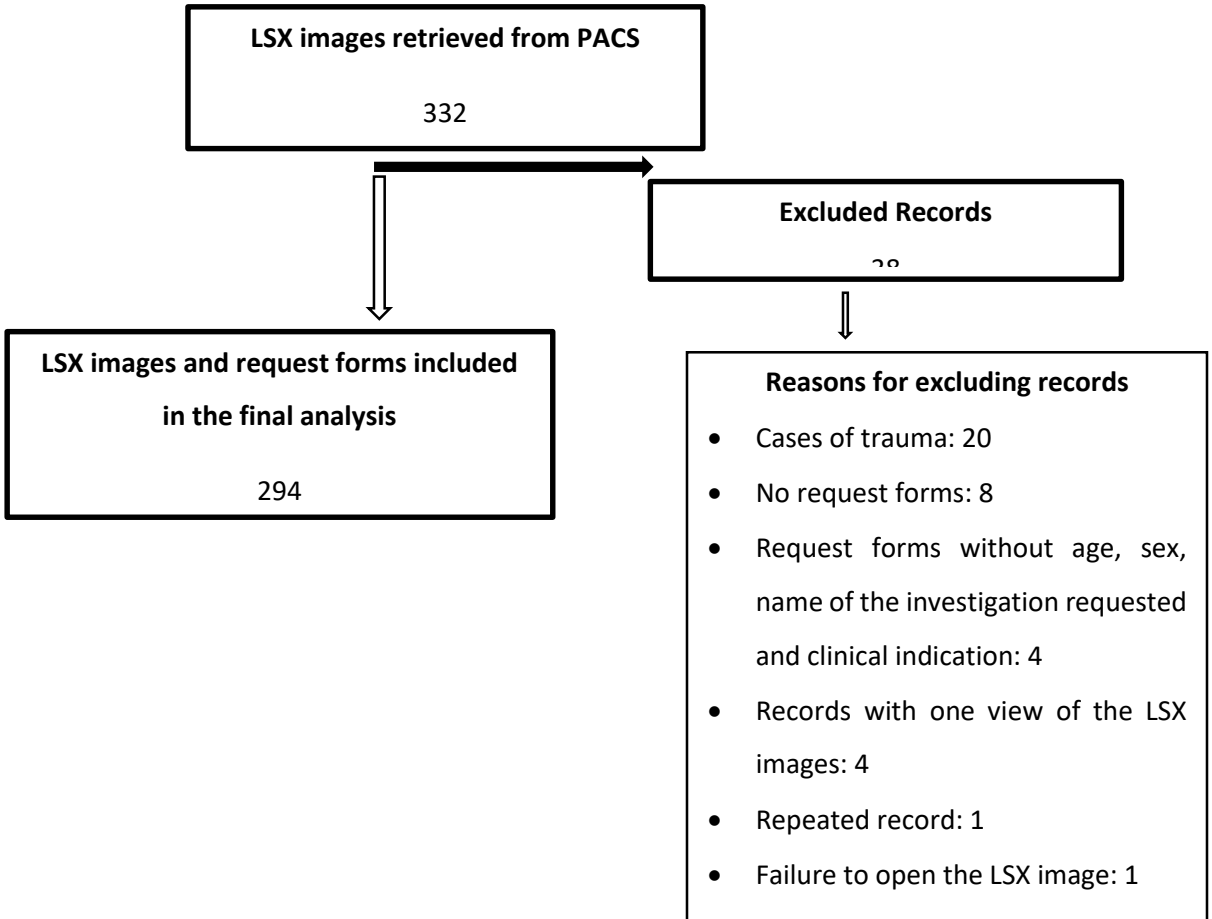
Ethical approval for this study was obtained on 16th December, 2024, and a patient consent waiver was granted by Mengo Hospital Research Ethics Committee (MH/REC/107/09-2024).

RESULTS

Demographic and clinical characteristics of children and young adults

In this study, 332 LSX images were retrieved from the Picture Archiving and Communication Systems (PACS). Overall, 38 images were excluded, as shown in Figure 1.

Figure 1. Illustrates the process of recruitment of records



Journal of Imaging Science for Diagnosis
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Case Report

All 294 records lacked information about the history of prior LBP management. The patient's mean (+/-standard deviation) age was 25.9 years (+/-6.4). The 37.8% were of the records belonged to patients aged 30-35 years, 51.7% were females, and 31% had no information about the duration of LBP, radiculopathy, and red flags of LBP, as shown in Table 1.

Table 1. Shows demographic and clinical characteristics

Patient Demographic and Clinical Characteristics			Frequency	Percentage (%)
Sex	Male		142	48.3
	Female		152	51.7
Age categories (years)	10-14		17	5.8
	15-19		38	12.9
	20-24		63	21.4
	25-29		65	22.1
	30-35		111	37.8
LBP duration	Less than 6 weeks/Acute low back pain		78	26.5
	6-12 weeks/Sub-acute low back pain		43	14.6
	Greater than 12 weeks/Chronic low back pain		82	27.9
	Not provided		91	31.0
Radiculopathy	Present		39	13.3
	Absent		164	55.8
	Information not provided		91	31.0
Red flag Signs in Low back pain	No information provided		91	31.0
	Absent		191	65.0
	Present		12	4.1
	The Red flag signs observed	1. Progressive motor/sensory weakness of the limb(s)	8	2.7
		2. Fever	1	0.3
		3. Immunosuppression	1	0.3
		4. Unexplained weight loss	1	0.3
		5. Urine incontinence	1	0.3

Appropriateness levels of LSX among children and young adults with non-traumatic LBP

The 65.7% of examinations were regarded as "usually not appropriate," 3.7% were found to be "May be appropriate," and 30.6% records had request forms that lacked adequate information to enable judgment of their level of appropriateness, as shown in Table 2.

Table 2: shows appropriateness levels of LSX based on ACR appropriateness criteria

Appropriateness levels	Frequency	Percentage (%)
Usually not appropriate	193	65.7
Maybe appropriate	11	3.7
Records lacking adequate information	90	30.6

Journal of Imaging Science for Diagnosis
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Case Report

LSX radiological findings among children and young adults with non-traumatic LBP

The 65% LSX had abnormal Radiologic findings while the rest were normal. Appropriateness levels did not have an influence on whether radiological findings were normal. However, being female had a significantly decreased likelihood of having normal LSX radiologic findings, as shown in Tables 3 and 4.

Table 3. Shows LSX radiological findings among children and young adults with non-traumatic LBP

LSX Radiological findings				**Frequency**	**Percentage (%)**
Overall	Normal LSX			102	35
	Abnormal LSX	Overall		191	65
		Reduced lumbar lordosis		153	80.1
		LSTV [b] and Castellvi classification types	Overall	52	27.2
			Type I	23	12.0
			Type II	11	5.8
			Type III	13	6.8
			Type IV	5	2.6
		Reduced vertebral heights		7	3.7
		Spondylosis		6	3.1
		Reversed lumbar lordosis		2	1.0
		Fish vertebrae		2	1.0
		Scoliosis		1	0.5
		Spina bifida occulta		1	0.5

In Table 3, [b] indicates abbreviation. LSTV is an abbreviation for Lumbo-sacral Transitional Vertebrae

Table 4. Shows results of binary logistic regression analysis

Demographic characteristics	and clinical	Number of LSX that were normal	The number of LSX was abnormal	COR [b] for LSX being normal	AOR [b] (95% CI) for LSX being normal	P-value
Sex	Male [1]	39	103	1	1	0.007
	Female	64	88	0.72	0.496 (0.297-0.828)	
Age categories	10-14 [1]	8	9	1	1	0.211
	15-19	9	29	0.63	3.256 (0.925-11.465)	
	20-24	19	44	1.82	1.844 (0.598-5.688)	
	25-29	27	38	1.31	1.162 (0.382-3.538)	
	30-35	40	71	0.79	1.459 (0.498-4.270)	
Duration of LBP	Less than 6 weeks [1]	21	57	1	1	0.123
	6-12 weeks	19	24	1.54	0.347 (0.147-0.823)	
	Greater than 12 weeks	30	52	0.72	0.675 (0.334-1.363)	
	No information provided on duration	33	58	0.99	358027288 (0.00)	
Radiculopathy	Present [1]	14	25	1	1	0.767
	Absent	56	108	1.08	1.130 (0.502-2.545)	
	No information provided	33	58	0.98	1 (-)	
Red flag signs	Present [1]	2	10	1	1	1.000
	Absent	68	123	0.36	528180798 (0.00)	
	No information provided	33	58	0.52	-	
Appropriateness level of LSX examination	Not usually appropriate [1]	68	125	1	1	1.000
	Maybe appropriate	2	9	2.45	528180798 (0.00)	
	Records without adequate information	33	57	0.94	1.04 (0.00)	

In the table, [1] indicates the reference category. [b] Indicates abbreviation, COR is crude odds ratio, AOR is adjusted odds ratio, and CI is confidence interval

DISCUSSION

Our study indicates non-traumatic LBP is a common reason for requesting LSX among children and young adults, though the majority (65.7%) of these examinations were inappropriate based on ACR appropriateness criteria. The inappropriate levels observed in this study are higher than those for Europe and the United States of America (30 – 34.8%) reported by meta-analytical studies. (Jenkins et al., 2018; Logan, 2019). Although methodological differences can lead to different findings, single facility cross-sectional studies carried out in Cameroon and Singapore report lower levels (and 48.7%, 30.7%, 36.2%) of inappropriate imaging. (Roger et al., 2022; Tay et al., 2023; Xuan et al., 2023). The lowest inappropriate levels are reported in a single facility cross-sectional study in Australia. (Traeger et al., 2021). The only studies that observe higher levels (80% and 85%) of inappropriate imaging were carried out in Ireland and Finland. (Reinhardt et al., 2024; Tahvonen et al., 2020)This is indicative of appropriateness levels varying from one Country to another, as well as from facility to facility, even within the same Country.

However, the differences in clinical imaging guidelines used as reference for defining appropriateness can explain differences in appropriate or inappropriate levels observed. Although this study relied on the latest version of the ACR guideline, the findings of Jenkins et al (2018) and Logan (2019) are based on older versions of ACR appropriateness criteria as well as other guidelines, yet the guidelines are revised over time (Hutchins et al., 2021; Simoni et al., 2023). In addition, Jenkins et al (2018) and Logan (2019) underrepresented LSX imaging, as the majority of studies included in their analysis were assessing appropriateness levels for MRI and or CT, yet LSX and CT/MRI are subjected to different guidelines. This can also explain the differences in our findings and those of Roger et al (2022), Reinhardt et al (2024), and Tahvonen et al (2020), who used imaging guidelines other than the ACR appropriateness criteria to define appropriateness.

Nevertheless, the differences in guidelines used to define appropriateness levels cannot account entirely for the differences in our findings and those of other studies. The studies of Xuan et al (2023) and Tay et al (2023b), which relied on the identical ACR appropriateness criteria as those used in this study, still showed differences in appropriateness levels. This could be attributed to the fact that our study was carried out in setting without any clinical imaging guideline to be used in selecting patients in need of LSX imaging while for Tay et al and Xuan et al they carried out the studies in settings where use of clinical guidelines was part of routine practice, suggesting high levels of inappropriate LSX imaging is due to sole reliance of clinical referrer's judgement unguided by any evidence based clinical decision tool. However, the findings of Reinhardt et al (2024), Tahvonen et al (2020), and Hiranandani et al (2018), who revealed the levels of inappropriate requests significantly increased over the years of introduction of imaging guidelines, and more experienced referrers were significantly associated with inappropriate requests, respectively contradict this assertion.

As expected, the high inappropriate levels observed in this study correspond to a very high yield of non-beneficial LSX radiological findings as far as management of LBP is concerned. In this study, the commonest abnormal finding was reduced lumbar lordosis, accounting for 80.1% of overall abnormal LSX, but no case of serious spinal pathology like fracture, infection, cancer, or spinal compression. This is consistent with clinical guidelines for management of LBP almost unanimous position that imaging is usually non-beneficial in nonspecific LBP (Bailly et al., 2021; Kreiner et al., 2020; Zhou et al., 2024). It is always important to remember that the ACR guidelines' purpose is to enable select patients with LBP who are likely to have beneficial imaging findings, i.e., findings that will foster better management.

Therefore, this study indicates potential in adopting the ACR guideline in the Ugandan setting in enabling appropriate selection of children and young adults experiencing non-traumatic LBP for LSX imaging. This study further demonstrates that LSX imaging is least likely to contribute to the management of LBP, once deemed inappropriate by the ACR guideline; the management of children and young adults can be done safely without LSX imaging. This study further demonstrates a potential challenge of using the ACR guideline in Uganda's clinical practice in the form of poor-quality request forms devoid of adequate information that can be a basis for defining appropriateness levels.

CONCLUSION

Most LSX examinations for non-traumatic LBP in children and young adults at Mengo Hospital were inappropriate based on ACR guidelines, with limited diagnostic benefit. The findings highlight the need for evidence-based imaging practices, improved clinical documentation, and integration of decision-support tools. Broader studies are recommended to assess imaging appropriateness across diverse healthcare settings in Uganda.

Study limitations

The interpretation of the guidelines was solely done by one of the investigators. This interpretation can potentially differ from other interpreters, thus the generalizability of the study's findings becomes less applicable.

This study observed a high proportion of records that could not be assessed for appropriateness criteria using the ACR guideline due to missing information. Therefore, the possibility that a high burden of inappropriate levels can be attributed to poor documentation of patient clinical indications and history cannot be ruled out.

List of abbreviations

ACR: American College of Radiology

CT: Computed Tomography
ECU: Ernest Cook University
LBP: Lower Back Pain
LSX: Lumbar Spine X-ray
MHREC: Mengo Hospital Research Ethics Committee
MRI: Magnetic Resonance Imaging.

Generalizability

The results were obtained from a single health facility, and so the results may not represent other institutions in the country. However, this facility is a referral and training health institute; hence, it provides a sneak peek into what exactly happens during training in other institutions.

Recommendations

This study recommends the adoption of the ACR Appropriateness criteria guidelines in hospitals in requesting LSX to reinforce safe utilization of the X-ray imaging modality. Greater emphasis should be placed on continuous teaching and practical training, as this will help address existing gaps in appropriate utilization.

Declarations

Consent for Publication

Not Applicable

Availability of Data and Material

The data supporting this study are available upon request from the Co-Responding Author.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding

This research had no funding.

Author's contributions

LW conceptualized the study, coordinated the research activities, and contributed to writing and reviewing the manuscript. AM contributed to analysis, writing, and reviewing the manuscript; HK provided overall mentorship, supervised, and provided overall guidance, resources, and ideas for the research.

Acknowledgements

We acknowledge Mr. Kule Joseph, who provided guidance in data analysis. We also acknowledge the efforts of Dr. Dennish Odongo, Dr. Namanda Justine, and Dr. Mbabazi Margaret, who interpreted LSX images for the radiological findings.

Author biography

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Dr. Harriet Kisembo serves as Head, Clinical Research and Continuous Professional Development at the Ernest Cook University in Mengo, Kampala, Uganda. She holds a PHD in Radiology, and she has published and co-authored numerous studies focused on imaging appropriateness and radiological protocol evaluation in low-resource settings. Her work encompasses advancing imaging protocols, optimizing modality selection, and promoting evidence-based diagnostic imaging practices in Uganda and the region.

Mr. Alen Musisi is a lecturer and clinical medical physicist at the Ernest Cook University in Mengo, Kampala, Uganda (Department of Applied Sciences). He holds an MSc in Medical Physics, and his areas of expertise include dosimetry, quality assurance/quality control (QA/QC) of diagnostic imaging equipment, radiation protection, treatment planning, and optimizing medical imaging in resource-limited settings.

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Journal of Imaging Science for Diagnosis
Vol. 2 No.6 (2026): June 2026 issue
https://doi.org/10.51168/xr1bhb36
Case Report

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Journal of Imaging Science for Diagnosis
Vol. 2 No.6 (2026): June 2026 issue
https://doi.org/10.51168/xr1bhb36
Case Report