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A Case Study Of Top Lordotic Chest Radiography Examination In Tuberculosis Cases At The Radiology Installation Of Universitas Gadjah Mada Academic Hospital

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ABSTRACT

Background: Pulmonary tuberculosis is a serious global health problem, with Indonesia ranking second worldwide for the highest case burden. Mycobacterium tuberculosis tends to colonize the lung apex; however, standard AP/PA projections present limitations due to clavicle superimposition, which creates a diagnostic blind spot. Current literature recommends an apical lordotic projection with a 15°-20° cephalad angulation, but its application in clinical settings is often adjusted to the patient's condition, resulting in angle variations that have not been scientifically evaluated. This study aims to analyze the 35° top lordotic chest technique and evaluate its diagnostic image value in tuberculosis cases at the Radiology Installation of RSA (Academic Hospital) UGM. Methods: This qualitative descriptive case study was conducted at the Radiology Installation of UGM Academic Hospital from February to May 2026. The subjects consisted of three radiographers and one radiologist, selected through purposive sampling. Data were collected via observation, semi-structured interviews, and PACS image documentation. The data were analyzed using the interactive model by Miles et al. (2014), encompassing thematic analysis, data display, and conclusion drawing/verification, utilizing source triangulation. Results: This technique was applied using an erect true AP position, a central ray of 35° cephalad, a central point at the manubrium sterni, 58 kVp, 8 mAs, and a 150 cm SID. It was utilized as a compensatory method for patients unable to perform an active lordotic position. The resulting images demonstrated bilateral lung apices free of clavicle superimposition, revealing infiltrates, consolidation, and fibrotic lines in the suprahilar, perihilar, and bilateral paracardial regions, suggesting bilateral pneumonia without ruling out TB. The radiologist affirmed that this technique provides clinical added value for the visualization of apical lesions. Conclusion: This technique serves as a rational clinical adaptation to patient limitations and produces images with adequate diagnostic value for evaluating the lung apex. It is recommended as a complementary examination, rather than a replacement for standard PA/AP projections. The definitive confirmation of tuberculosis still necessitates clinical correlation and ancillary tests, such as Acid-Fast Bacilli (AFB) sputum smears or cultures.

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1. INTRODUCTION

Pulmonary tuberculosis is still a very serious global health challenge. Indonesia ranks second with the highest burden of tuberculosis cases in the world. Bacteria *(World Health Organization, 2025) Mycobacterium tuberculosis* It is aerobic that tends to colonize in areas with high oxygen pressure, namely in the apecs of the lungs. Therefore, the ability to detect clinical manifestations such as infiltrates, cavities, or fibrosis in the apexes area early determines the effectiveness of treatment and the prevention of further transmission. (Piccazzo et al., 2016)

Allah SWT says in QS. Ash-Shu'ara (26): 80 which means:

"And when I was sick, He was the one who healed me."

The above verse explains that Allah SWT did not create a disease but also created a healer or cure. The verse also explains that every disease only comes from Allah SWT and every cure will only come from Him, including pulmonary tuberculosis.

Allah SWT sent down diseases that aim to increase the faith of His creatures and has provided a cure, one of which is through supporting examinations in the form of radiography techniques *thorax top lordotic* to help establish an accurate diagnosis so that the right antidote can be found. The ability to detect clinical manifestations such as infiltrates, cavities, or fibrosis in the area of pulmonary apexes early is a form of effort that is in line with the command of Allah SWT to always strive to maintain health.

Radiographs *Chest* It is the most widely used first-line imaging modality in diagnostic workflows due to its wide availability, affordable cost, and ability to provide initial information quickly. However, the standard projections (Tárnoki et al., 2024) *Antero-Posterior* (AP) or *Postero-Previous* (PA) has a fundamental weakness, namely the occurrence of shadow superposition *clavicula* and *costae* the upper part that covers the area of the apexs of the lungs, so that small lesions in that region have the potential to go undetected. (Tárnoki et al., 2024)

Lampignano & Kendrick, (2018); Long et al., (2018) recommends the use of projections *Apical Lordotic*. This technique is theoretically able to shift the projection *clavicula* towards *superior* So that pulmonary apecs can be visualized more clearly. The standard position requires the patient to lean back by 30° from the vertical position, or use a 15°-20° beam angle in the direction *cephalad* alternatively. concludes that the AP projections Judge (2022) *Axial* provides a more optimal and more comfortable picture for patients compared to *lordotic* conventional, whereas found that variations in irradiation angles significantly affected the clarity of anatomical information of pulmonary apex. Sapphire (2025)

To date, there have been no scientific studies that systematically evaluate the diagnostic information generated from the top-lordotic thorax radiography technique with an angle of 35° *cephalad* in a real clinical context in tuberculosis patients. Studies have examined angular variations experimentally in the 15°-30° range, but have not evaluated the diagnostic quality of this technique in tuberculosis patients with positional limitations in the clinical setting. studied lordotic techniques in general, but did not focus on 35° angle modification in response to the patient's limited clinical condition. This gap is the scientific basis for the need for comprehensive case-based research. Sapphire (2025) Hakim (2022); Harahap et al. (2023); Legiana (2016)

Reality in the field shows that tuberculosis patients often come in a weak condition, shortness of breath, and experience stiffness (tightness) in the neck, so that the patient is unable to perform *the lordotic* position optimally, either by leaning backwards or with neck hyperextension as required in the *lordotic* apical projection standard. This condition prompted radiographers at the Radiology Installation of the Academic Hospital of Gadjah Mada University to apply a modification of the examination technique, namely by positioning the patient as much as possible accompanied by giving a central beam direction angle of 35° towards *the cephalad*, which is hereinafter known as the *thorax top lordotic* technique. It should be emphasized that this modification is not a standard procedure that is always applied to every *thorax top lordotic examination*, but a decision made by the radiographer based on the evaluation of the patient's physical condition individually at the time of the examination, so that the amount of angle applied can vary in each case according to the level of limitation of the patient. However, the angle of 35° applied significantly exceeds the recommended limit of the standard *apical lordotic projection*, which is 15°-20° towards *the cephalad* as defined by . In addition to the difference in angle magnitude, the literature also recommends the (Lampignano & Kendrick, 2018; Long et al., 2018) *AP Axial approach*, which is the position of the patient standing upright (*true* AP) with *the central ray* directed 15°-20° towards the *cephalad* as an alternative technique for patients who are unable to maintain *the lordotic* position fully active. These deviations have the potential to cause geometric distortions in radiographic images that can affect the accuracy of radiological interpretation, so it is necessary to scientifically examine whether the quality of the diagnostic information produced remains adequate to support the enforcement of the diagnosis of pulmonary tuberculosis. (Tárnoki et al., 2024)

This study aims to find out the radiographic examination technique of the upper *lordotic thorax* with the addition of an angle of 35° in tuberculosis cases at the Radiology Installation of the Academic Hospital of Gadjah

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Mada University, and to find out the diagnostic information produced from the *upper lordotic thorax examination technique* with the addition of an angle of 35° in tuberculosis cases in the installation.

2. LITERATURE REVIEW

1. Pathology of tuberculosis paru

Tuberculosis is a chronic infectious disease caused by *Mycobacterium tuberculosis*, an obligate aerobic bacterium that tends to colonize areas with high oxygen pressure, namely pulmonary apexes. This explains why the radiological manifestations of tuberculosis are almost always concentrated in *the apical* and *posterior segments of the superior lobe* (Bhalla et al., 2016; Piccazzo et al., 2016) . Indonesia ranks second with the highest burden of tuberculosis cases in the world, making early detection through imaging an urgent public health issue. (World Health Organization, 2025)

The radiological picture of active tuberculosis in the apex region includes *infiltrates, consolidations, fibrotic lines, small nodules*, and cavities in more advanced cases. affirms that the diagnostic criteria for imaging pulmonary tuberculosis rest on the accurate identification of such patterns in the apical region, while explaining that fibrotic lines indicate a chronic inflammatory process that has already taken place, and the absence of cavitates does not necessarily rule out the active process because the caseosa necrosis may not have fully thawed. added that the interpretation of (Tárnoki et al., 2024) He et al., (2023) Kumar & Dhingra, (2023) Morbée & Gosselin, (2024) *thorax images* in tuberculosis still requires correlation with supporting examinations such as BTA sputum or culture, because the radiological picture alone is not yet definitive. This description is the basis for understanding the findings of the pathological picture evaluated in the image of *the top lordotic* technique results in this study.

2. Limitations of Thorax Standard Projection

Postero-Anterior *(PA) and* Antero-Posterior (AP) *standard projections* are first-line modalities in the tuberculosis diagnostic pipeline due to their wide availability and affordable cost. However, these two projections have a fundamental weakness in the form of the superposition of the shadow of (Tárnoki et al., 2024) *the clavicula* and upper *costae* against the pulmonary apecs, so that small lesions in the region are at risk of escaping detection. Note that the diagnostic accuracy of (Tárnoki et al., 2024) Piccazzo et al., (2016) *thorax radiography* for tuberculosis varies quite widely depending on the quality of the reading and the ability of the image to visualize APECS independently of bone superposition. It is this limitation that underlies the need for additional projections that specifically exclude the *clavicula* from the apexes area . (Piccazzo et al., 2016)

3. Technique Radiography *Thoracic AP Lordotic*

a. Clinical Indications and Examination Preparation

According to the apical projection Lampignano & Kendrick, (2018) *lordotic* is indicated to rule out the possibility of calcification and masses that are in the area below the *clavicula*. Preparation for the examination includes explaining the procedure to the patient, removing metal objects around the chest, and installing radiation protection on the reproductive organs as needed. This preparation is used as a comparative reference to evaluate the suitability of patient preparation in the case studied, including the use of additional personal protective equipment for radiographers in cases with suspected active tuberculosis.

b. Technical Factors

The minimum source-to-image receptor (SID) distance used is 72 inches (183 cm). The size of the image receiver (IR) used is 35 × 43 cm (14 × 17 inches), can be positioned in portrait or landscape, with the use of grid. For analog and digital systems, the tube voltage range used is in the range of 110-125 kVp.

c. Patient Position

Fig. 2.70 AP lordotic position.

Figure 1. AP *Lordotic Position*
(Lampignano & Kendrick, 2018)

The patient is positioned to stand approximately 30 cm in front of the IR, then lean back until the shoulders, neck, and back of the head are attached to the IR. The patient's hands are placed at the waist with the palms facing out, while the shoulders are rotated forward.

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d. Object Position

The patient's midsagittal plane is positioned parallel to the *central ray* (CR) and the IR midline. The cassette is positioned in such a way against the CR, with the upper limit of the IR being about 7-8 cm above the patient's shoulder in patients of average body size.

e. Central Ray dan Central Point

In the standard *lordotic* position (standing), the CR is directed perpendicular to the IR, centered on the *midsternum*, approximately 9 cm (3-4 inches) below the *jugular notch*.

f. Colimasi

Colimation is carried out on all four sides until it covers the area of the pulmonary field, with the upper limit of the collimation field as high as *the prominent vertebrae.*

g. Breathing

The exposure is carried out at the end of the second full *inspiration.*

h. Alternative Projection *(Semiaxial AP)*

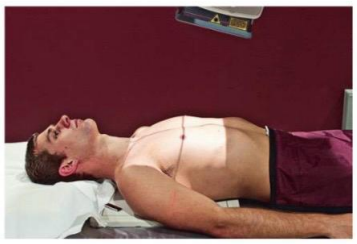

Fig. 2.71 Alternative: Semiaxial AP.

Figure 2. *Semiaxial AP Position*
(Lampignano & Kendrick, 2018)

For patients who are weak or unable to maintain an active standing lordotic position, semiaxial AP projection with the supine patient position can be used. The shoulders remain rotated forward as in the lordotic position, but the CR is directed 15°–20° towards the cephalad, centered on the midsternum.

i. Image Evaluation Criteria

Figure 3. Radiograph Imaging *AP Lordotic* (Lampignano & Kendrick, 2018)

Visualized anatomy: the entire lung and *clavicula* should be covered in the image.

Position: *the clavicula* appears almost horizontal and is above or *superior* to the pulmonary apex, with the *medial part of the clavicula* superimposed with the first rib. The ribs appear distorted, with the posterior ribs appearing almost horizontal and superimposed on the anterior ribs. No rotation is characterized by the *sternal ends of the clavicula* spaced equally from the vertebral column on both sides, and the lateral limits of the ribs of both sides spaced almost equally from the *vertebral column.* The center of the collimation field is in the midsternum with the collimation boundaries visible at the top and bottom of the image.

Exposure: no *visible motion*, the contours of the diaphragm, heart, and ribs appear sharp. The optimal contrast and exposure scale allows visualization of fine vascular images of the lungs, particularly in the apexic and airy areas of the upper lungs.

4. Geometric Distortion on *the Lordotic AP Projection*

Distortion is a change in the shape or relative size of an object's shadow due to a geometric mismatch between the ray source, the object, and the detector. In *the top lordotic projection*, shape distortion is actually used as a working principle: the shrinkage of the *cephalad* causes the *clavicula* to be projected in a superior direction beyond the pulmonary apecs. The greater the (Hollman & Adams, 2020) *angle of cephalad* contraction used, the greater the

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effect of elongation and distortion of the shape produced, whereas magnification is determined by SID and (Chaitanya et al., 2024) *Object to Image Distance* (OID) the shorter the SID or the larger the OID, the greater the magnification of the image. (Ringin et al., 2025)

Riska Nuzuli, (2022) tested the variations in the angle of contraction of 0°, 15°, 20°, 25°, and 30° *cephalad* on *the anteroposterior projection of the clavicula* and concluded that the angle of 30° provided the most optimal result in freeing the *clavicula* from the superposition of the surrounding structure. These findings reinforce the principle that an increase in *the angle of the cephalad* is directly proportional to the effectiveness of *clavicle release*, as well as being a comparative reference for assessing the effect of elongation at an angle of 35° beyond the optimal point. Remind that understanding this geometric distortion is important so that anatomical shape changes in images are not misinterpreted as pathological abnormalities by the reader's radiologist. Bhalla et al., (2016)

3. METHOD

This research is a qualitative descriptive research with a case study approach. This approach was chosen because it aims to understand in depth the radiographic examination technique of the *upper lordotic thorax* with an angle of 35° *cephalad* as well as the diagnostic information produced in tuberculosis cases at the Radiology Installation of the Academic Hospital of Gadjah Mada University.

The research was carried out at the Radiology Installation of the Academic Hospital of Gadjah Mada University in the period from February to May 2026. The research subjects consisted of three radiographers and one radiologist who were selected *purposively* based on the predetermined exclusion criteria. The radiographer inclusion criteria include: (1) radiographers who are directly involved in the implementation of *thorax top lordotic* examination with researchers at the time of data collection, and (2) radiographers who have more than 10 years of work experience at the Radiology Installation of the Academic Hospital of Gadjah Mada University. The inclusion criteria for radiology specialists are doctors who are actively in charge of reading and interpreting radiograph images from examinations at the installation. The object of the research was in the form of techniques and images *of the upper lordotic thorax* radiographic examination with an angle of 35° *cephalad* in tuberculosis patients.

Data collection was carried out through three methods, namely direct observation of all stages of the examination procedure, semi-structured in-depth interviews with three radiographers (Informant I, II, III) and one radiologist (Informant IV), as well as documentation of radiographic images and metadata from the PACS system along with the patient's medical records that have been anonymized. The validity of the data is guaranteed through triangulation of sources, namely by comparing and crossing data from three sources simultaneously, namely the results of direct observation of examination procedures, information obtained from radiographers, and statements of radiological specialists, so that consistent findings between the three sources can be declared valid.

The data analysis in this study refers to an interactive model consisting of three continuous stages. The first stage is thematic analysis, which is the process of sorting and focusing relevant information from observations, in-depth interviews, and documentation, in order to simplify raw data into meaningful units. The second stage is the presentation of data, which is carried out in the form of a systematic narrative description that describes the examination process comprehensively accompanied by a critical comparison of the applicable literature standards. The third stage is conclusion drawing and verification, which is an inference process that is carried out in stages to answer the formulation of the research problem based on the overall data that has been thethematically analyzed and presented. Thematic analysis in the first stage was applied to identify, classify, and interpret recurring themes from all data sources, especially themes related to the clinical rationality of technique application, the suitability of technical parameters to the literature standards, and the diagnostic value of the resulting imagery. Miles et al. (2014)

This research has fulfilled the principles of research ethics, including patient *confidentiality*, the principle *of nonmaleficence* (not increasing radiation exposure because it uses secondary data), and scientific integrity in the presentation of data. Ethical approval was obtained from the Ethics Committee of RSA UGM with number 136/RSA/KEP/EC/2026, with all patient data having been anonymized according to the principle of confidentiality of health research.

4. RESULTS

1. Case Exposure

The patient on behalf of Mrs. W, female, aged 39 years 8 months 27 days, came to the pulmonary polyclinic of Gadjah Mada University on February 10, 2026 with complaints of coughing with phlegm for more than two weeks, significant weight loss, night sweats, fatigue that does not improve after rest, tightness in the neck, and mild shortness of breath during activities. Based on the anamnesis and clinical examination, the doctor suspects pulmonary

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tuberculosis infection and refers the patient for a *top-lordotic thorax radiographic examination* to optimally evaluate the area of pulmonary apex. The patient's identity is presented in Table 1.

Table 1. Patient Identity

Description	Remarks
Name	Mrs. W
Age	39 years 8 months 27 days
Gender	Women
Inspection Date	February 10, 2026
Rooms	Radiology Nakula
Types of Inspections	*Thorax top lordotic*
Diagnosis	Tuberculosis

3. *Lordotic Top Thorax* Examination Procedure with a 35° angle in tuberculosis cases at RSA UGM

a. Projection Objectives

In general, the *top-lordotic thorax projection* aims to display the area of the pulmonary apexs independently of the overlapping *of the clavicula* and *costae*, so that abnormalities in the area such as infiltrates, cavities, or fibrotic lines in tuberculosis cases can be identified more clearly than conventional AP or PA projections, in which the pulmonary apecs are still partially covered by the shadow of the clavicula. This goal was affirmed by Informant I from the radiographer's point of view, who explained that the evaluation of image adequacy is always returned to the basic purpose of this examination. Informant I stated

> "For example, for the criteria, what is the purpose of the Lordotic AP examination? What you want to see is the apex part, especially. For example, if the AP or PA position is ordinary, it is not covered with the clavicle, while the goal is to make the top lordotic so that it is thrown, so later the apex part is visible. So we have to make sure that for example the apex is visible and clear."

The purpose of this projection was also confirmed from a clinical point of view by Informant IV as a radiology specialist, who emphasized that the *top lordotic projection* is indeed specifically intended for the evaluation of the pulmonary apecs area, not to replace the standard thoracic projection as a whole. Informant IV states

> "If it's topolordotic, we actually just want to see the apex. But if for example the thorax as a whole, yes, it is better with a regular thoracic examination such as the standard PA. But for apeks, it's really the best with a top-notch top."

Furthermore, Informant IV also explained the added value of this projection compared to the standard projection, especially in the case of lesions located in the apeks pulmo area, as stated

> "So, for example, topalordotic is needed for lesions in the apeks pulmo, which sometimes with the position of AP or PA is superposition with the clavicula or costae. For lesions in apex, it means that he is good for helping to determine lesions in apexes."

Based on the explanation of the two informants, the purpose of the *top-lordotic thorax projection* basically has two complementary dimensions, namely the technical dimension from the radiographer's side which seeks to ensure that the clavicle is thrown in a superior direction through *central ray incision* so that the pulmonary apexs area is free from superposition, and the diagnostic clinical dimension from the side of the radiologist who uses this projection to obtain special visualization of the area of pulmonary apexs that cannot be optimally obtained through standard PA or AP projections, especially to detect and determine the location of lesions in the apexes pulmo area that often overlap with *the clavicula* or *costae*.

b. Patient Preparation and Equipment

Based on the results of observations and interviews, there is no specific preparation for this examination; the preparation is basically the same as a *typical thorax* examination , which is the removal of metal objects around the chest area that have the potential to cause artifacts, such as jewelry and wire bras. Informant I stated

> "... There is actually no special preparation like a typical thorax exam. So if you can remove the metals around the chest as much as possible, it is better. Anticipation will be better because it avoids the presence of metals such as BH and others."

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In addition to the standard preparation, the radiographer who handled this case applied additional precautions in the form of the use of double-layer masks and N95 masks because the patient was suspected of having active tuberculosis. Informant II stated

> "... Let's anticipate. He is the patient who suspects TB. For example, if you suspect TB, what is the transmission through? So we anticipate it there. Maybe we use the mask in double, if not the N95 one."

The tools used are a Canon brand Digital *Radiography (DR*) X-ray unit with a maximum kVp capacity of 125-150 kVp, equipped with *a vertical* buckystand for *an erect position* that allows the angle of the tube to be adjusted up to 35° *cephalad*, as well as a digital detector (*flat panel detector* / FPD) measuring 35×43 cm.

c. Patient Position and Object Position

Based on the observation results, it is known that the patient has a weak and stiff condition in the neck, and cannot be positioned ideally. The patient's position on this examination *is lordotic* as much as possible for the patient's physical condition, with the body tilt adjusted based on his ability to be about 10cm from the *buckystand*.

In this case, the patient's weak clinical condition and shortness of breath render the patient unable to actively tilt the body, so that the *lordotic position* that can be achieved is only as far as the patient is able, and the compensation is fully diverted to the *central ray* incision of 35° towards the *cephalad*. This is in accordance with the interview of Informant II which stated that

> "For example, for the patient, it is better, we will see first how the condition is, if for example his position can be leaning backwards, you can, but if for example you can't, we will use him standing. Later we will arrange it in the collimation, in the tube. We are a little modified in the corners."

Based on the results of further observations, it is known that the RSA UGM Radiology Installation does not have any fixation devices or special handles (such as *chest* boards) that can help patients maintain *their lordotic* position safely. The absence of these aids is also one of the radiographers' considerations in determining the extent to which the patient's body tilt can be maximized. Informant II stated

> "We don't have a handle either, right, it means there is no fixation device, if he goes back and keeps his hands like this, there will be a prisoner, later he will be afraid that if we maximize it will suddenly collapse or whatever, it will be an incident later."

The position of the object in this examination was adjusted to the condition of the patient who was only able to stand upright as far as approximately 10 cm from the *buckystand*, with *the patient's body midsagittal plane* positioned in line with the *central ray* and the midline *of the image receptor* (IR). The patient's shoulders are rotated forward and both hands are placed at the waist with the palms facing outwards, although the degree of body tilt achieved is not optimal due to the patient's physical limitations. The IR is positioned with an upper limit of approximately 7-8 cm above the patient's shoulder, to ensure that the bilateral pulmonary apecs area remains within the collimation limit despite elongation due to *large central ray* suction . The reason for using the 35° angle in this case was also explained directly by Informant I regarding clinical considerations in the field

> "Maybe if for example 35 degrees is obtained from us adjusting the patient's condition again. Whether it can really be done with a backward tilt position or not, we adjust it again. If the inclination is maximum, maybe 15 to 20 is enough. But if he is in a normal position and his back is not optimal, there are limitations, we will modify it there."

d. Central *Ray*, *Central Point*, and Colimation Settings

Based on the results of observation, *the central ray* (CR) was directed by 35° towards the *cephalad*, as compensation for the patient's inability to perform *an active* lordotic position.The *central point* is fixed in the middle of the sternum (*manubrium sterni*).

> "The central point in collimation is like collimation in general for thorax photos, but later it will definitely experience elongation, because there is a large contraction of 35 degrees. Then for the central point of the ray, it is in the middle of the sternum."

Colimation is adjusted to the area of the object, covering the entire area of the bilateral pulmonary apexs to the lower boundary *of the bilateral* clavicula.

e. Expos Parameters

Based on the observation results, the exposure parameters used were kVp 58, mAs 8, and SID 150 cm. There are no specific parameter adjustments for tuberculosis patients. The selection of parameters is carried out based on the patient's habitus. Informant I stated

> "For kV and mAs, it's actually the same... So there are no special adjustments. It's just that for the term, we also depend on the object. It can be small, it can change. So we minimize the radiation given to patients."

This was confirmed by Informant III

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"The exposure parameter is usually for thoracic photos, the kVp is between 57 to 60, then the mAs is between 5 to 10, then the SID is usually for the thorax is 150."

f. Evaluation of Images, Expert Results, and Diagnostic Information

Before being handed over to the radiologist, the radiographer conducts an independent evaluation with the following criteria: no objects are cut, the density and contrast of the image are sufficient, and *the clavicula* is projected over the pulmonary apecles so that the apexs area is free from superposition, in line with the main purpose of the *thorax top lordotic* examination itself, which is to throw the *clavicula* in the superior direction so that the pulmonary apecs are visualized free of superposition. Informant I stated

"As for the criteria, there is actually none. As usual, the object has been met, nothing is cut, and the contrast density is sufficient, because it can be set in advance before it is sent. So the important thing is that there is no object that is cut, the most important thing is that as much as possible the clavicle has been thrown out of the apex, which shows that the apexes have been freed from the clavicle, that is enough."

Based on the results of the experiment by dr. Sp.Rad. on May 4, 2026, the photo of *the top lordotic* projection thorax shows inspiration and sufficient condition.

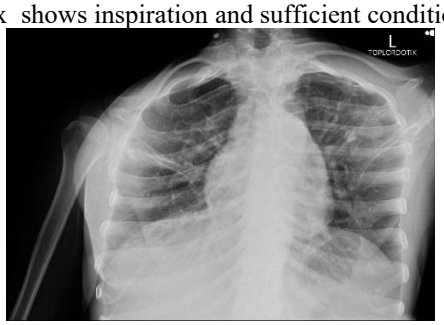

Figure 4. Radiographic Imaging *of Thorax Top Lordotic* Angle 35° *Cephalad* in Pulmonary Tuberculosis Patients

The thorax radiographic image of the *35°* cephalad *angle of top lordotic* projection in Figure 4 shows a fairly good quality, with an even density between the lungs, soft tissues, and bones so that it does not appear *overexposed* or *underexposed*; sufficient contrast to distinguish the boundaries of the heart, lungs, and bone structures; anatomical details visualized are quite clear in the pulmonary vascular, lines fibrotic, as well as the arch of the first and second ribs in the superior direction; and good image sharpness without *motion blur,* characterized by firm heart and diaphragm contours. The apparent anatomy includes both pulmonary apexes, the bilateral clavicle projected in the superior direction, the entire pulmonary field, the heart, both hemidiaphragms, and the indented bony system, with the upper limit of the image covering the pulmonary apecles in full and the lower margin covering both *costophrenicus* sinuses without being cut,

Radiological findings include infiltrates with consolidation and *fibrotic* lines in *bilateral suprahilary*, *perihilary*, and *paracardial pulmo*; no *visible bilateral hilus lymphodine* compaction or bilateral pleural space *dilation*; *bilateral hemidiaphragm* is smooth and non-horizontal; *Cast*, CTR = 0.45; and the visualized bone system indent. Effect: *bilateral pneumonia*, has not been able to rule out the possibility of TB, large *normal cast*.

Further diagnostic assessment by the radiologist (Informant IV) confirmed that the bilateral pulmonary apecs had been free of *clavicle superposition* and was symmetrical enough for the purpose of right-left comparison, and no cavities were found despite the appearance *of infiltrates* accompanied by *fibrotic* lines in the left lung field. Overall, this technique is considered to provide added value in clarifying abnormalities in the apeks area of the lungs. Informant IV concluded

"Good. Yes, it means that he has added value, yes, to make it clearer if there are really abnormalities in the apex area."

5. DISCUSSION

1. Lordotic Top Thorax *Radiography Examination Procedure* with 35° *Cephalad Angle*

a. Patient Preparation and Equipment

The thorax *examination technique* at RSA UGM is carried out with general preparations only, namely the removal of metal objects around the chest so as not to cause artifacts in the image, but there is an additional PPE used by radiographers, namely the use of double-layer masks and N95 masks because the patient is suspected of having active tuberculosis, without the use of a gonadal apron even though the patient is of reproductive age. The preparation of the tool is carried out using a digital radiography unit with *a buckystand*.

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According to , the preparation for the Long et al., (2018) *apical lordotic projection examination* includes explaining the procedure, removing metal objects, and installing a gonadal apron as part of radiation protection efforts in the reproductive organs, considering that the infusion of the tube towards *the cephalad* has the potential to increase scattered radiation to the pelvic area.

The use of N95 respirator masks in this examination serves as the main physical barrier against the transmission of *Mycobacterium tuberculosis* through *the airborne route*, considering that this type of mask is designed to adjust the contours of the wearer's face so as to minimize air leakage at the edges of the mask and is able to filter at least 95% of very small air particles, including *nuclei* droplets carriers of tuberculosis bacillus, this is in line with the recommendations of the WHO and CDC which recommend the use of N95 masks not just surgical masks for medical personnel who treat patients with suspected aerosol-transmitted infections such as pulmonary tuberculosis, and supported by meta-analysis results that show the superiority of N95 masks over surgical masks in preventing airborne respiratory infections. (Barycka et al., 2020)

According to the researcher, the preparation of patients and the preparation of tools carried out at RSA UGM are more or less the same as the theory, only there is an additional use of PPE, namely N95 masks by radiographers in this case, the researcher also assesses that the application of PPE in this case shows a difference with those that explicitly include the installation of radiosensitive shields outside Lampignano & Kendrick, (2018) *the area of interest (shielding)* as part of the preparation of standard *examinationsapical lordotic*, so that the incompatibility between practice in the field and the theoretical reference needs to be a separate evaluation record for the implementation of the next examination.

b. Patient Position and Object Position

In the case of Mrs. W who performed a *top-therotic thorax examination* with tuberculosis clinicians at RSA UGM, the patient's clinical condition was weak, shortness of breath and stiffness in the neck which caused the patient to be unable to actively tilt the body, so that the position that could be achieved was only standing upright in front of *the buckystand* with *the lordotic position* only as much as the patient could do, which was 10cm away from the *buckystand*, with all projection compensation shifted to *central ray shrinkage*.

According to , the standard position on Lampignano & Kendrick, (2018) *apical lordotic* projection consists of two approaches, namely patients leaning back 30cm from the vertical position with *the central ray* perpendicular to the center, or *supine* patients with *the central ray* directed 15°-20° towards *the cephalad* as an alternative for patients who are unable to perform the *full active* lordotic position.

According to the researchers, the selection of a *lordotic* standing position as far as the patient can in this case is the right decision and oriented towards patient safety, as forcing a backward inclined position on a weak patient risks a fall or aggravating shortness of breath, so this approach demonstrates the radiographer's ability to carefully read the patient's clinical condition before determining the modification of the technique applied.

c. Central *Ray*, *Central Point*, and Collimation Settings

At Mrs. W's examination, the central ray was directed by 35° towards the *cephalad* to compensate for the patient's inability to perform an active *lordotic* position , with *the central point* set in the middle of the sternum (*manubrium sterni*) and the collimation adjusted covering the entire area of the bilateral pulmonary apexes to the lower limit *of the clavicula* bilateral. This 35° angle is the result of a case-by-case adjustment and is not a standard set of installation SOPs.

The decision not to impose an active *lordotic position* in Mrs. W's case was based on strong clinical considerations, given that complaints of shortness of breath, coughing up phlegm, and stiffness in the neck inhibited the patient's ability to hyperextend the body backwards which is the main requirement of *the standard lordotic* position , so that the compensation of the projection geometry was completely diverted to central ray stubbornness. This condition is aggravated by the unavailability of fixation devices such as *chest boards* or special handles at the RSA UGM Radiology Installation, so that forcing patients to lean back risks causing fall incidents, the radiographer emphasized that the absence of these aids is the main consideration in modifying the technique, with patient safety being prioritized over the technical perfection of the position.

According to recommending a Lampignano & Kendrick, (2018) *central ray angle* of 15°-20° towards *the cephalad* for apical lordotic *projection* with the patient standing upright, and the larger the angle of *cephalad* confluence used, the greater the effect of elongation and shape distortion on the image. Other research findings also support that modification of the angle of the splice outside the standard recommendations is a common practice found in *the top lordotic technique* to overcome the limitations of the patient's position, in her research at the Fatmawati Central General Hospital it was found that (Legiana, 2016) *the top lordotic* technique was modified by combining *bucky stand* infusion of 30° posteriorly and *central ray* infusion of 15° *cephalad*, as a solution for elderly patients or patients whose bodies are stiff so that they are unable to position themselves in an *active lordotic*, and conclude that

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the modification remains effective in producing a picture of pulmonary apexs that is free from clavicle superposition while improving patient comfort during the examination.

According to the researchers, the use of a 35° angle that exceeds the standard recommendations can be understood as a form of rational technical compensation for the limitations of the patient's position and not as a misimplementation of the technique, in line with the literature that modification of the angle of contraction is a reasonable approach to be applied when the patient's condition does not allow the standard position to be performed. The choice to keep the patient in an *erect position* while shifting the entire geometric compensation to central ray shrinkage, instead of imposing an active *lordotic position* without the support of a fixation device, is also the right decision and is oriented towards patient safety, as forcing a backward inclined position on a weakened patient risks a fall or aggravating shortness of breath. However, because the application of this 35° angle is based on subjective considerations on a case-by-case basis without more detailed angle guidance nor the availability of fixation tools. The researcher suggested that the RSA UGM Radiology Installation needs to consider the preparation of additional technical guidelines and the procurement of fixation aids, so that the image quality remains consistent and patient safety is more guaranteed at various degrees of patient limitations in the future.

c. Expos Parameters

The exposure parameters used in the examination of Mrs. W's case were kVp 58, mAs 8, and SID 150 cm. There is no specific parameter adjustment for tuberculosis patients, and the selection of parameters is made based on the patient's habitus. The results obtained are able to display the image of the infiltrate and fibrotic lines clearly enough so that diagnostic information can be interpreted by a radiologist specialist.

Based on the findings of the study, the use of kVp 58 and mAs 8 in this case is still in a corridor that is close to the optimal conditions for Ambarsari et al., (2016) *thorax* examination. Although the kVp value used was slightly higher than the 55 kV that was the optimum point in the study, this difference was still within acceptable tolerances given the variation in patient habitus.

According to the researcher, the exposure parameters applied at the RSA UGM Radiology Installation were proven to be able to produce images with adequate diagnostic information for Mrs. W's case, while still paying attention to the principle of optimization by maintaining a balance between image quality and radiation dose received by patients.

2. Diagnostic Information for Top *Lordotic Thorax Radiography* Images with 35° *Cephalad Angle*

a. Criteria for Radiographic Imaging *of the Lordotic Top Thorax* with an Angle of 35° *Cephalad*

The resulting image shows that the *clavicula* is successfully projected in a superior direction, so that the bilateral pulmonary apecs are visualized free of clavicle superposition and are symmetrical enough for the purpose of right-left comparison, without any anatomical parts being cut at the upper or lower boundaries of the image. However, there is a significant elongation of the anatomical structure due to the large angle of suction used, as well as the lateral part of the clavicle which on some sides is still curved and has the potential to cover part of the lung area.

According to , the ideal Lampignano & Kendrick, (2018) *lordotic apical image criteria* include the projection of the clavicle over the pulmonary apecs so that the apex area of the lungs is free of superposition, the two apical apecs appear symmetrical and uncut, there is no rotation characterized by the same distance of the sternal ends of the clavicle to the vertebral column on both sides, as well as the center of collimation being in the midsternum with the collimation boundaries visible at the top and bottom of the image. This is in line with the findings of his research on the variation of the contraction in the anteroposterior projection Riska Nuzuli, (2022) *of the clavicula*, which tested the angles of 0°, 15°, 20°, 25°, and 30° *of the cephalad* against the level of *overlapping of the* anatomical os *clavicula*, and concluded that the 30° contraction *of the cephalad* was the most appropriate angle to free the *clavicula* from superposition with the surrounding structure.

According to the researchers, the use of a 35° *cephalad angle* in this case that was above the recommended optimal angle of 30° still managed to meet most of the ideal radiography criteria, in particular the liberation of the pulmonary apecs from the clavicle superposition Riska Nuzuli, (2022) and the symmetry of the two apexes. However, significant *elongation* and *clavicula* lateralis that actually close part of the lung area indicate that an increase in angle of up to 35° carries technical consequences that do not fully correspond to the ideal criteria, so the distortion needs to be explicitly communicated to the image reader doctor so as not to be misinterpreted as an anatomical abnormality.

b. Top Lordotic Thorax *Radiography Image Quality* with 35° *Cephalad Angle*

Overall, the images show a sufficient and even density between the lung area, soft tissue, and bone structure, without appearing *overexposed* or *underexposed*. The resulting contrast scale is adequate to distinguish the boundaries of the heart, lungs, and rib and vertebral bone structures. Anatomical details are well visualized, especially in the vascular structure of the lungs in the apek and perihilar areas, fibrotic lines, and the contours of the rib bones that curve towards the superior according to the characteristics of *lordotic projection*. Image sharpness is also relatively good,

characterized by the absence of blurring due to the patient's movement (*motion*) during exposure, with the contours of the heart and diaphragm appearing firm.

According to , the use of low kVp with adjusted mAs in a Ambarsari et al., (2016) *Computed Radiography* system can produce optimal image quality for conventional thorax examination, taking into account the balance between image quality and the radiation dose (*Entrance Surface Dose*) received by the patient. The exposure parameters used in this case, namely kVp 58 and mAs 8, were in a corridor close to the optimum condition although slightly higher, given the variation in the patient's habitus.

According to the researcher, the quality of the images produced in this case is quite good and able to support the need for diagnostic interpretation, shown by the visualization of the infiltrate and fibrotic lines clearly by the radiologist This shows that the selection of exposure parameters at the RSA UGM Radiology Installation has considered the principle of dose optimization without sacrificing the required diagnostic information.

c. Diagnostic Information Based on Radiology Specialists

Experimental results showed the presence of infiltrates with consolidation and *fibrotic* lines in *the suprahilary, perihilary,* and *paracardial regions of* the bilateral lungs, without the presence of cavities, lymphocytic compaction of the hilus, or dilation *of the pleural space*, slippery and non-horizontal bilateral hemidiaphragm, heart size within normal limits (CTR = 0.45), and an indented bony system, with the impression of bilateral pneumonia and the possibility of bilateral pneumonia tuberculosis that has not been eliminated. The radiologist considers that this technique provides added value in clarifying abnormalities in the area of the pulmonary apex, which in standard projections PA/AP often overlaps with *the clavicula* or upper *costae*, but still insists that for the evaluation of the *thorax* as a whole, the standard PA projection remains the main examination.

According to , the active picture of tuberculosis in Kumar & Dhingra, (2023) *the thorax photo* is generally characterized by infiltrates or consolidation especially in the apical and posterior segments *of the superior lobe*, while the fibrotic picture shows chronic changes due to a previously occurring inflammatory process, and the absence of cavities indicates that the *process of caseosa* necrosis has not melted or is not large enough to be detected on this projection. In line with this, stating that the superposition of the Bhalla et al., (2016) *upper clavicula* and *costae* on the standard projection is a fundamental limitation that can cause small lesions in the apexs region to go undetected, so that a specific projection that frees the area from superposition has diagnostic added value for cases with suspicion of apical lesions.

According to the researchers, the diagnostic information generated in this case is sufficient to support the clinical suspicion of tuberculosis, especially in clarifying abnormalities in the area of pulmonary apexs that have the potential to escape detection on standard projections. However, the absence of cavities in the image should not be directly interpreted as the absence of an active process, but rather needs to be correlated with other supporting examinations for a more thorough clinical interpretation, and this technique is best positioned as a complementary examination to *the standard thorax* projection , not as a substitute for the overall *thorax* evaluation .

6. CONCLUSION

The radiographic examination technique *of the upper thorax lordotic* with an angle of 35° *cephalad* in tuberculosis cases at the RSA UGM Radiology Installation was carried out with standard patient preparation in the form of the removal of metal objects around the chest, accompanied by additional caution in the form of the use of double-layer masks and N95 masks considering the suspicion of active tuberculosis in the patient, without the use of gonadal aprons even though the patient is of reproductive age. The patient's weak clinical condition, shortness of breath, and neck stiffness became the basis for the selection *of an erect* position without active hyperextension, with the entire projection geometry compensation shifted to the *central ray* infiltration of 35° *cephalad*, *the central point* in the *manubrium sterni*, as well as the exposure parameters kVp 58, mAs 8, and SID 150 cm. The use of a 35° angle that exceeds the standard literature recommendation of 15°-20° has been proven to be a form of rational technical compensation for the limitations of the patient's position and the absence of fixation devices in the installation, with the determination being based on case-by-case considerations and not standard operating procedure standards.

The image produced in this case successfully shows *the clavicula* projected in a superior direction so that the bilateral pulmonary apecs are visualized as free of superposition and quite symmetrical, accompanied by significant elongation of anatomical structures as a consequence of the large angle of contraction used. The quality of the resulting images is adequate in terms of density, contrast, detail, and sharpness, so that it is able to display an image of infiltrates, consolidations, and fibrotic lines in the *suprahilary, perihilary,* and *paracardial regions of* the bilateral lungs without the presence of cavities, which supports the impression of bilateral pneumonia with the possibility of tuberculosis that has not been eliminated. The clinical added value of this technique is emphasized by radiologist in clarifying abnormalities in the area of pulmonary apexes that are often disguised due to the superposition *of the clavicula* or

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costae on the standard projection of AP/PA, so that the *top lordotic technique* in this case proved to be effective as a complementary examination for the evaluation of pulmonary tuberculosis, not as a substitute for *the standard thorax* projection as a whole.

The Radiology Installation of RSA UGM is recommended to prepare additional technical guidelines related to the limit of *central ray* suction in patients with limited position and consider the procurement of fixation aids to reduce the risk of falling, the use of N95 masks in cases of suspected active tuberculosis needs to be maintained with consistency in the use of gonadal aprons in patients of reproductive age as the application of intact radiation protection principles, and information about the magnitude of the angle of contraction used needs to be clearly communicated to the image reader doctor so that the elongation effect is not misinterpreted as an anatomical abnormality.

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