Majority Science Journal (MSJ) Vol. 4 No. 2, May 2026
P-ISSN: 0000-0000; E-ISSN: 3025-1990
Available : https://jurnalhafasy.com/index.php/msj DOI: https://doi.org/10.61942/msj.v4i2.579

Comparison of Variations in the Angle of the 0° and 10° Cephalad Beam Direction in Anteroposterior (AP) Projection Pedical Examination to Show More Informative Anatomy

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Input :April, 21 2026 Revised : May 05, 2026
Accepted :May 07, 2026 Published : May 13, 2026

Abstract

The anteroposterior (AP) projection of the Ossa Pedis examination technique in some hospitals typically uses a perpendicular 0° beam angle, while the theoretical approach uses a 10° cephalad beam angle. This study aims to compare variations in 0° and 10° cephalad beam angles and provide more informative anatomical information. The study used a quantitative experimental approach in the Radiology Laboratory of the Faculty of Vocational Studies, Baiturrahmah University, from June to August 2025. The study involved a population of 79 individuals and a sample size of 3 individuals. Data were collected through radiographic images and then assessed by 5 radiology specialists and 25 radiographers using a questionnaire with a 5-item Likert scale. Question 1 depicts the anatomy of the tarsal bones, Question 2 depicts the space between the metatarsals, Question 3 depicts the lower part of the metatarsals, Question 4 depicts the joint space between the medial cuneiform and the intermedial cuneiform, Question 5 depicts the joint space between the interphalangeal joint, metatarsophalangeal joint, and tarsometatarsal joint. Data processing using SPSS with the Wilcoxon test is presented in figures and tables. Based on the results, the 0° angle produced a lower average value of 17.64, while the 10° cephalad angle produced a more optimal image with a higher average value of 22.72. This image has the advantage of a more open joint space, a more defined metatarsal base, and clearer alignment of the foot bones due to reduced superposition. With a p-value of <0.005, it can be concluded that there are differences in the anatomical images in the anteroposterior (AP) projection pedis examination at 0° and 10° cephalad angles.

Keywords: Radiography, Pedis, Anteroposterior, Anatomy

Citation :
Mareta S et al 2026 Comparison of Variations in the Angle of the 0° and 10° Cephalad Beam Direction in Anteroposterior (AP) Projection Pedical Examination to Show More Informative Anatomy *MSJ: Majority Science Journal*, *4*(2), 48-55

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P-ISSN: 0000-0000; E-ISSN: 3025-1990
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1. Introduction

Radiology is a branch of medicine that examines and diagnoses human organs using radio waves. This field is divided into two categories: diagnostic radiology and radiotherapy. Radiology services are available at various healthcare facilities, including community health centers (Puskesmas), private clinics, and hospitals throughout Indonesia. In its implementation, radiology services must be accompanied by special attention to the safety of the surrounding community (Trikasjono et al., 2015).

One examination related to conventional radiology is the Pedis examination. The Pedis is the lowest bone in the lower extremity. In one pedis, there are 26 bones divided into 3 groups: 14 phalanges, 5 metatarsals, and 7 tarsals. Phalanges are the most distal bones of the foot that form the toes. Metatarsals are the bones of the instep. In the tarsals, there are 7 bones: the calcaneus, talus, cuboid, navicular, and cuneiform bones, which are divided into 3 parts: medial, intermedial, and lateral (Lampignano & Kendrick, 2018).

Based on the results of research in the first journal written by (Wahyuni et al., 2018) entitled The Effect of Anteroposterior (AP) Projection Os Pedis Examination with Perpendicular Ray Direction 0° and Axial 10° on the Results of Ossa Tarsal Radiographs. The purpose of this study was to determine the differences in the use of 0° and 10° angled beam directions on tarsal ossa radiographs with Ossa Pedis examination. In this study, the results of the tarsal ossa radiograph image using 10° showed a 78.3% more open joint gap and 70% clearer tarsal ossa anatomy than using a 0° perpendicular beam direction.

In the second study written by (Wibowo et al., 2021) entitled Anatomical Information of Radiographs with and Without X-ray Tube Angle in AP Projection Pediatric Examination. The AP projection pediatric radiographic examination technique between without 0° angle and with 10° angle with posterior ray direction towards the heel produces different anatomical information. When using the ray direction without 0° angle and using 10° angle in the phalanges, metatarsals, and tarsals bone structure appears to elongate, so that when using the 10° angled ray direction it is clearly visible with a p-value <0.05. Anatomical information of the pedis radiograph with the use of 10° angle is well visualized, namely the interphalangeal joint space, metatarsophalangeal joint space, tarsometatarsal joint space, navicular, and cuboid (Wibowo et al., 2021).

This study aims to determine the comparison of variations in 0° and 10° cephalad beam angles in anteroposterior (AP) projection pedis examinations and to find out which ray direction is more capable of showing more informative anatomy in pedis examinations using angle variations of 0° and 10°.

2. Method

The type of research used is quantitative with experimental studies,conducted at the DIII Radiology Laboratory of the Faculty of Vocational Studies, Baiturrahmah University in May-June 2025 with a population of 79 Radiology students from the class of 2022 at Baiturrahmah University. The technique for determining the number of samples used purposive sampling, in this study using a sample of 3 patients and 30 respondents consisting of 5 Radiology Specialists and 25 Radiographers.

The instruments used in this study were Questionnaire Forms, Digital Radiography X-ray Machines, Digital Radiography Computers, Film, Printers, Detectors, Control Panels.

Data was taken through radiographic image capture and assessed by respondents using a questionnaire with a 5-question Likert scale, in question 1 the anatomical description of the Ossa Tarsalia, question 2 the description of the space between the metatarsals, question 3 the description of the lower part of the metatarsal, question 4 the description of the joint space between the medial cuneiform and the intermedial cuneiform, question 5 the description of the interphalangeal joint gap, metatarsophalangeal joint, and tarsometatarsalia joint.Data processing was done using SPSS with Univariate and Bivariate analysis, then the data was presented in table form.After that, conclusions and suggestions are drawn.

P-ISSN: 0000-0000; E-ISSN: 3025-1990
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3. Results and Discussion

Result

A. Sample Documentation 1

Figure 1 Documentation of sample 1 anteroposterior projection 0°

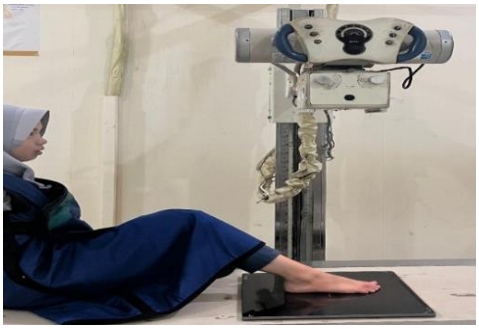

Figure 2 Documentation of sample 1 10° anteroposterior projection

B. Sample Radiograph Results

Figure 1 Radiograph results of sample 1

Figure 2 Radiograph results of sample 2

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Figure 3 Radiograph results of sample 3

B. **Univariate Analysis**

Table 1 Frequency and Percentage of Answers for Ossa Pedis Anteroposterior Projection 0°

	Anteroposterior 0°										
	Answer										Mean
	TJ		KJ		CJ		J		SJ		
	N	%	N	%	N	%	N	%	N	%	
Ossa Tarsalia	0	0	1	1.1	15	16.7	71	78.9	3	3.3	3.84
*Space*between Metatarsal II-V	0	0	1	1.1	32	35.6	42	46.7	15	16.7	3.79
Lower part of Metatarsal II-V	0	0	1	1.1	58	64.4	31	34.4	0	0	3.33
*Space Joint*Med	0	0	8		52	57.8	23	25.6	7	7.8	3.32

ial and Intermedial Cuneiform				8.9							
IP Joint, MTP Joint, TM Joint Gap	0	0	3	3.3	54	60.0	31	34.4	2	2.2	3.36

Table 2 Frequency and Percentage of Answers for Ossa Pedis 10° Anteroposterior Projection

Question	*Anteroposterior*10° Answer										Mean
	TJ		KJ		CJ		J		SJ		
	N	%	N	%	N	%	N	%	N	%	
Ossa Tarsalia	0	0	0	0	2	2.2	21	23.3	67	74.4	4.79
*Space*between Metatarsal II-V	0	0	3	3	2	2.2	60	66.7	25	27.8	4.19
Lower part of Metatarsal II-V	0	0	0	0	2	2.2	56	62.2	32	35.6	4.33
*Space Joint*Medial and Intermedial Cuneiform	0	0	0	0	4	4.4	18	20.0	68	75.6	4.71
IP Joint, MTP Joint, TM Joint Gap	0	0	0	0	3	3.3	15	16.7	72	80.0	4.77

C. Bivariate Analysis

Table 3 Mean rank values

Ossa Pedis Anteroposterior Projection		
Angle of Light Direction	Mean	P Value
0°	17.64	0,000
10°	22.72	

Table 4 Statistical Test Results for Question 1

Descriptive Statistics

	N	Mean	Standard Deviation
0° cephalad angle	90	3.84	,472
10° cephalad angle	90	4.72	,498

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Table 5 Statistical Test Results for Question 2

Descriptive Statistics

	N	Mean	Standard Deviation
0° cephalad angle	90	3.79	,727
10° cephalad angle	90	4.19	,634

Table 6 Statistical Test Results for Question 3

Descriptive Statistics

N		Mean	Standard Deviation
0° cephalad angle	90	3.33	,497
10° cephalad angle	90	4.33	,519

Table 7 Statistical Test Results for Question 4

Descriptive Statistics

	N	Mean	Standard Deviation
0° cephalad angle	90	3.32	,747
10° cephalad angle	90	4.71	,546

Table 8 Statistical Test Results for Question 5

Descriptive Statistics

N		Mean	Standard Deviation
0° cephalad angle	90	3.36	,587
10° cephalad angle	90	4.77	,498

Table 9 Statistical Test Results for Total Questions

Descriptive Statistics

	N	Mean	Standard Deviation
0° cephalad angle	90	3.36	,587
10° cephalad angle	90	4.77	,498

Test Statistics

Z	-8191
Asymp. Sig (2-tailed)	,000

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a. Wilcoxon Signed Ranks Test
b. Based on negative ranks

Discussion

1. Differences in the Variation of the Direction of the Light Angle of 0° and 10° Cephalad in the Anteroposterior (AP) Projection Pedis Examination to Show a More Informative Anatomical Image

In question 1, the examination of the Ossa Pedis at a 10° angle shows a very good anatomical image of the toes to the tarsal bones because the joint space is more open, the phalangeal bones with the metatarsal bones do not superimpose each other and the tarsal bones have more detailed bone boundaries. Compared to a 0° angle where the joint space image does not open and the tarsal bones superimpose with the metatarsal base.

PThere is a 10° angle of the image between Ossa Metatarsal II-IV, the gap between the Base of Metatarsal IIIV appears more open and not superposed with the intermedial cuneiform and lateral cuneiform. Compared with the 0° angle in which the results of the metatarsal space image appear asymmetrical and the gap between the superposed metatarsal base with the intermedial cuneiform and lateral cuneiform.

At an angle of 10°, the anatomical image of the lower part of the metatarsal (base metatarsal) is slightly superposed, especially between the base metatarsal II, III, IV, the boundary between the metatarsal base bone and the intermetatarsal joint is clearer and slightly superposed. Compared to an angle of 0°, the anatomical image of the base metatarsal is superposed with the intermetatarsal joint.

At an angle of 10°, the image of the joint gap between the medial cuneiform and the intermedial cuneiform appears to be more open and not superposed so that the boundary between the medial cuneiform and the intermedial cuneiform bones is clearer. Compared to an angle of 0°, the anatomical image of the joint gap between the medial cuneiform and the intermedial cuneiform is slightly open so that the boundary between the medial cuneiform and the intermedial cuneiform bones is not clearly visible.

At 10° angle, the anatomical image of the interphalangeal joint gap is more open, so it is not superimposed with the distal metatarsal, the metatarsalphalangeal joint appears more open and not superimposed so that the metatarsalphalangeal joint gap has clearer bone boundaries, the tarsometatarsal joint gap appears more open and not superimposed, so that the boundary between the metatarsal and cuneiform, cuboid is more defined. Compared to 0° angle, the anatomical image of the interphalangeal joint gap is slightly superimposed with the distal metatarsal bone, the metatarsalphalangeal joint appears less open so that it looks superimposed between the proximal phalanges and distal metatarsals, the tarsometatarsal joint appears superimposed with the metatarsal base.

2. The angled direction of the light is better able to show informative anatomy

The results of this study were to obtain an Anteroposterior Projection Pedis with a 10° cephalad angle to show more informative anatomy using a 10° ray direction because in the Anteroposterior Projection Pedis examination with a 10° cephalad ray direction, the average weight mean score was 22.72 and could provide more informative Anteroposterior Projection Pedis information seen from the questionnaire data that had been filled out by the respondents.

According to Long et al., 2016, the purpose of the pedis radiographic examination is to evaluate the overall structure of the bones and joints of the foot and the most optimal angle to show the Pedis Anteroposterior Projection with a ray direction of 0̊ and 10° cephalad is the ray direction of 10° cephalad, because it can reduce superposition between bones, open the joint space of the tarsometatarsalia joint and improve visualization of the metatarsal structure.

At 10° angle, the most visible differences are the superposition of the calcaneus and talus, the navicular bone, the medial cuneiform joint space and the intermedial cuneiform are more open, the lateral cuneiform is slightly superposed with the cuboid bone, the subtalar joint is superposed, the cuneonavicular joint is open, the superposition of the cuneocuboid joint is

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Available : https://jurnalhafasy.com/index.php/msj DOI: https://doi.org/10.61942/msj.v4i2.579

slightly superposed and open, the metatarsal base is slightly superposed, the metatarsal bone digits 1-5 are visible, the metatarsal space is not superposed, the metatarsophalangeal joint is open, the phalanges bone digits 1-5 are visible, the interphalangeal joint is slightly open. Based on these results, the author explains that 10° angle is more informative in terms of joint space anatomy, metatarsal base, and foot bone alignment because overlap is reduced so that it can establish better results compared to 0° angle. However, the 0° angle also has other anatomical advantages for viewing bone structures in general, especially long bones such as phalanges and metatarsals.

4. Conclusions and Suggestions

In an anteroposterior projection with a 10° cephalad beam, this is considered good to use because the tarsal bones are very clearly visible, the space between metatarsal IIV is clearly visible, the lower part of metatarsal II-V is clearly visible, the joint space of the medial cuneiform and intermedial cuneiform is very clearly visible, the joint space of the interphalangeal joint, metatarsal joint, tarsometatrsalia joint is very clearly visible.

From the results of research and data processing carried out on anteroposterior (AP) projection pedis examination with a 10° cephalad beam angle, it produces more informative anatomy because it can show better pedis bone anatomy compared to a 0° beam angle, the results of the Wilcoxon statistical test show a P value of 0.000 <0.05.

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