Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 3
Open Access

Characteristics of the Acetabulum in Patients at Dr. Saiful Anwar General Hospital from 2021 to 2023

Domy Pradana Putra*, Edi Mustamsir, Ahmad Muhsinin
Department of Orthopaedic and Traumatology, Faculty of Medicine Universitas Brawijaya – Dr. Saiful Anwar General Hospital, Malang, East Java, Indonesia
*corresponding author: Domy Pradana Putra (domy_pradana@ub.ac.id)

Cite this paper as: Domy Pradana Putra, Edi Mustamsir, Ahmad Muhsinin (2024) Characteristics of the Acetabulum in Patients at Dr. Saiful Anwar General Hospital from 2021 to 2023. *Frontiers in Health Informatics, 13* (3),4025-4032

A B S T R A C T

Introduction: *The pelvis and acetabulum are critical anatomical structures that support body weight and protect vital organs. This study aims to gather data on various anatomical parameters of the pelvis, such as the Acetabular Index, Wiberg's Center-Edge Angle (CEA), Femoral Neck Angle, Hip Joint Space, Skinner's Line, and Teardrop Distance, to better diagnose orthopaedic conditions.*

Methods*: This descriptive study analyzed data on patients who underwent AP pelvic radiography at Dr. Saiful Anwar General Hospital in Malang between January 2021 and December 2023. The data was collected through the Radiology Information System (RIS). The study included patients aged 18-40 with adequate AP pelvic radiographs and no history of congenital abnormalities, fractures, ligament injuries, or surgeries. The data was analyzed using SPSS 25 to find each parameter's mean and standard deviation.*

Results: *The study examined the acetabulum's radiological parameters in 200 subjects. Results showed an Acetabular Index greater than 33°, indicating a risk of hip dysplasia. The central edge angle was within the normal range, the Femoral Neck Angle was below normal, indicating a tendency toward coxa vara; the Hip Joint Space was normal, the Teardrop Distance was within the normal range, and the Tönnis Angle was within the normal range.*

Conclusions: *The study found that the mean Acetabular Index was slightly above the normal range, followed by the average Tönnis Angle, which was 5.10°. This indicates a tendency toward inclination, potentially leading to hip dysplasia, and other measurements are normal.*

Keywords*: acetabulum, anatomy, hip dysplasia, pelvis, radiography*

INTRODUCTION

The pelvis and acetabulum are essential parts of the human skeletal system, playing a vital role in supporting body weight, enabling movement of the lower limbs, and protecting vital organs such as the bladder, reproductive organs, and the terminal part of the digestive tract. As the biomechanical fulcrum, the complex structure of the pelvis, particularly the acetabulum, is crucial in forming the ball-and-socket joint with the femoral head. This joint allows extensive movement while maintaining stability during physical activities.[1]

The acetabulum consists of three bone components: the ilium, ischium, and pubis, which merge to form the cavity where the femoral head articulates. Acetabular development begins early in fetal life and continues through adulthood. Initially, the acetabulum forms as a flexible cartilaginous structure, but over time, the ossification process transforms it into solid bone, providing better stability for the hip joint.[2] Genetic factors, physical activity, mechanical load, and trauma to the pelvic region influence variations in acetabular

morphology development. These morphological changes can lead to clinical conditions such as hip dysplasia and femoroacetabular impingement. In addition to developmental variations, other factors like trauma or direct injury to the pelvis can also affect the acetabular structure.[3,4]

Various imaging techniques are used to assess the morphology of the acetabulum and the hip joint. Anteroposterior (AP) pelvic radiography is the standard method for evaluating several key anatomical parameters, such as the Acetabular Index, Wiberg's Center-Edge Angle (CEA), and the Femoral Neck Angle. These parameters provide information about the angle and depth of the acetabulum and the alignment of the femoral head within the acetabulum. For example, the Acetabular Index is used to assess the inclination angle of the acetabulum. In contrast, the CEA of Wiberg is used to determine the lateral coverage of the femoral head by the acetabular roof. Abnormalities in these parameters can indicate hip dysplasia, subluxation, or an increased risk of joint degeneration.[5]

In addition to radiography, three-dimensional imaging techniques such as CT scans and MRIs provide more detailed images of bone morphology and the surrounding soft tissues in the hip joint. CT scans are particularly useful for assessing complex deformities of the acetabulum, while MRIs are more beneficial for evaluating soft tissue conditions, such as labral tears or cartilage damage.[5,6]

Understanding the anatomy and morphological variations of the acetabulum, as well as the appropriate use of imaging techniques, is crucial in managing various orthopaedic conditions, including hip dysplasia, pelvic fractures, and femoroacetabular impingement. Accurate evaluation not only aids in diagnosis but also helps in planning optimal surgical interventions or rehabilitation therapies for patients. Therefore, this study aims to gain various anatomical parameters of the pelvis data, such as the Acetabular Index, Wiberg's Center-Edge Angle (CEA), Femoral Neck Angle, Hip Joint Space, Skinner's Line, and Teardrop Distance for better diagnosing the orthopaedic condition.

METHODS

Study Design

This research is a descriptive study. Data was collected on patients who underwent AP pelvic radiography at Dr. Saiful Anwar General Hospital in Malang between January 2021 and December 2023. The research data was collected through the Radiology Information System (RIS) between July and September 2024. Pelvic and acetabular anatomical parameters were measured using RIS features. This study received ethical approval from the General Hospital Saiful Anwar Ethics Committee with the number (400/293/K.3/102.7/2024).

Participants

The population in this study consisted of patients treated at Dr. Saiful Anwar General Hospital, Malang, aged 18-40 years, who underwent AP pelvic radiographs from 2021-2023. The inclusion criteria included patients who had adequate AP pelvic radiographs at Dr. Saiful Anwar General Hospital with no history of congenital abnormalities, fractures, ligament injuries, or surgeries in the pelvic and acetabular regions. Exclusion criteria included incomplete patient data, such as missing name, age, gender, and patients whose radiological results had technical issues that could not be further analyzed.

Data Collection

Data was collected by accessing patient's electronic medical records through the hospital's RIS system. After obtaining permission for data access, the radiology team analyzed the AP pelvic radiographs. Acetabular morphology parameters were measured digitally using measurement software within the RIS. The collected data was then exported into a format suitable for statistical analysis. The variables analyzed in this study included various anatomical parameters of the pelvis, such as the Acetabular Index, Wiberg's Center-Edge Angle (CEA), Femoral Neck Angle, Hip Joint Space, Skinner's Line, and Teardrop Distance.

Data Processing

Data recording was done digitally and compiled using Microsoft Excel. The range of values for the Acetabular Index, Wiberg's Center-Edge Angle (CEA), Femoral Neck Angle, Hip Joint Space, Skinner's Line (Femoral Angle), Teardrop Distance, and Tönnis Angle were presented as descriptive data, showing mean values and standard deviations after statistical analysis using Statistical Product and Service Solutions (SPSS) 25th.

RESULTS

This study was conducted on 200 subjects at Dr. Saiful Anwar General Hospital, Malang, to measure the radiological parameters of the hip joint, including the Acetabular Index, Central Edge Angle (CEA) of Wiberg, Femoral Neck Angle (FNA), Hip Joint Space, Teardrop Distance, and Tönnis Angle. Figure 1 showed that the mean Acetabular Index was 35.33°, slightly above the normal range (30°-33°), indicating a tendency toward acetabular inclination, potentially leading to hip dysplasia. All subjects had an Acetabular Index above 33°. Meanwhile, the average Central Edge Angle (CEA) of Wiberg was 32.11°, within the normal range (20°-40°), demonstrating adequate acetabular coverage of the femoral head, suggesting that most subjects had sufficient protection against hip dislocation, as seen in Figure 2.

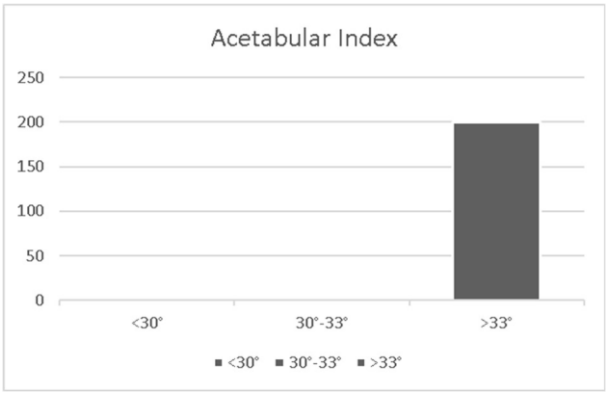

Figure 1. Acetabular Index Measurement Result

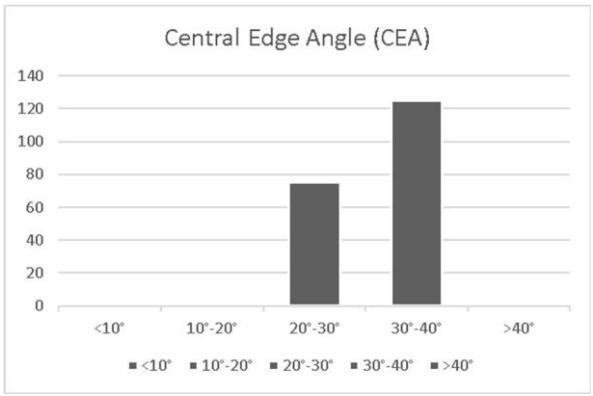

Figure 2. CEA Measurement Result

The mean Femoral Neck Angle (FNA) was 122.63°, slightly below the normal value (125°-135°), indicating a tendency towards coxa vara in some subjects, which could affect load distribution in the hip joint. Figure 3 shows that all subjects had FNA values below 125°. Hip Joint Space measurements showed that the average superior space was 4.61 mm (Figure 4), medial 5.17 mm (Figure 5), and axial 8.91 mm (Figure 6), reflecting relatively preserved joint cartilage. The normal hip joint space does not exceed 6 mm superiorly, 7 mm axially, or 13 mm medially.

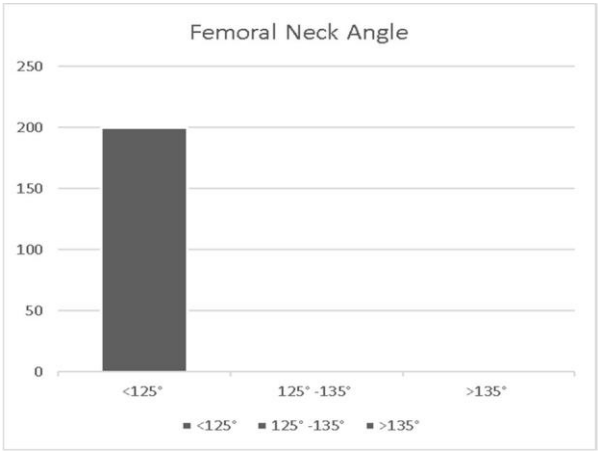

Figure 3. Femoral Neck Angle Measurement Result

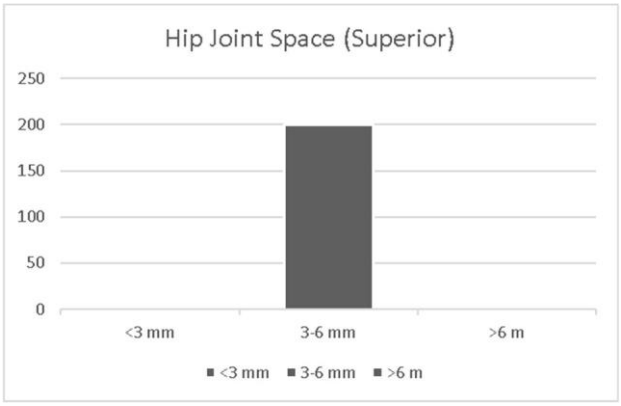

Figure 4. Superior Hip Joint Space Measurement Result

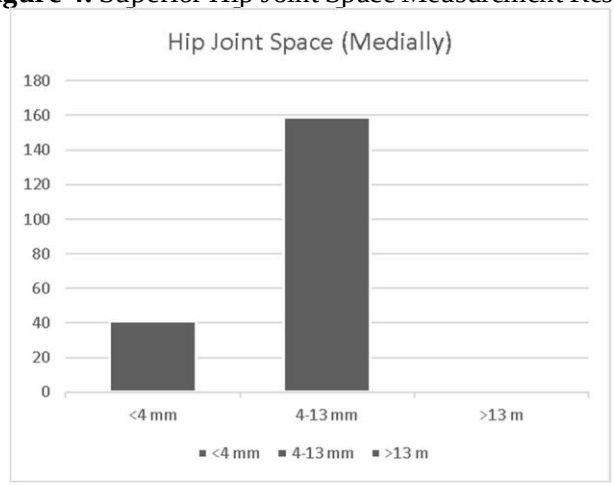

Figure 5. Medial Hip Joint Space Measurement Result

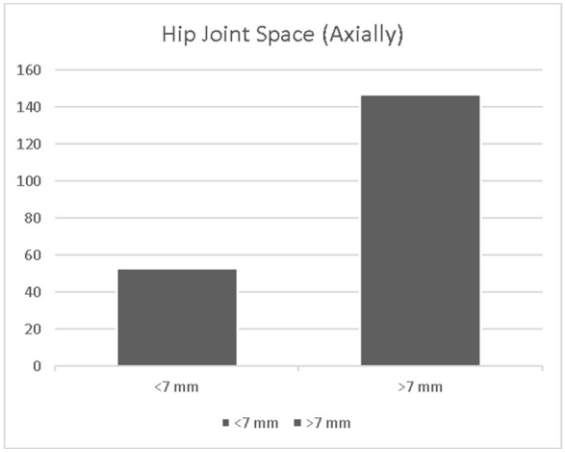

Figure 6. Axial Hip Joint Space Measurement Result

The average Teardrop Distance of 6.86 mm was within the normal range, with 105 subjects falling within the normal range of 6-11 mm, indicating that most subjects did not exhibit significant joint space narrowing, as seen in Figure 7. Finally, Figure 8 shows the mean Tönnis Angle was 5.10°, also within normal limits (0°-10°), indicating that the acetabular tilt in most subjects was normal. However, 100 subjects were closer to the lower end of the range (5°-10°), suggesting an increased risk of hip dysplasia.

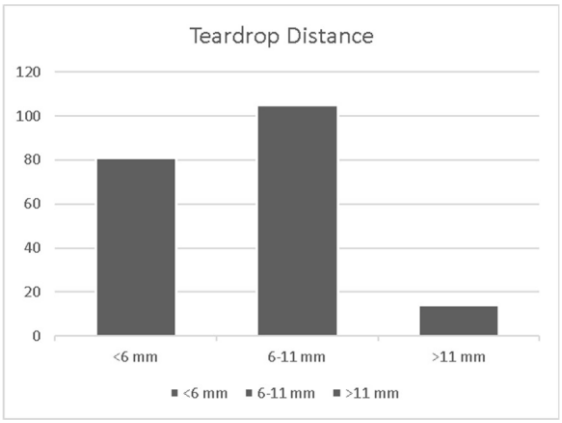

Figure 7. Teardrop Distance Measurement Result

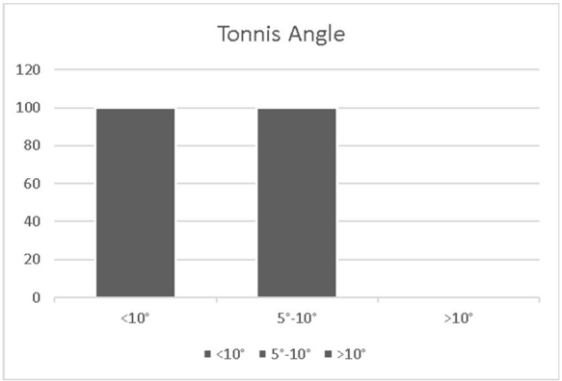

Figure 8. Tonnis Angle Measurement Result

DISCUSSION

This study evaluated radiological parameters in 200 subjects, focusing on the Acetabular Index, Central Edge Angle (CEA) of Wiberg, Femoral Neck Angle, Hip Joint Space, Teardrop Distance, and Tönnis Angle. These results are crucial for assessing potential structural and biomechanical abnormalities of the hip joint, which can lead to various pathologies such as hip dysplasia, Femoroacetabular Impingement (FAI), or osteoarthritis.

The mean Acetabular Index of 35.33° was slightly above the normal range (30°-33°). According to Schwabe et al. (2019), an Acetabular Index above normal may indicate an increased risk of hip dysplasia, especially in young, active individuals.[7] A high Acetabular Index indicates that acetabular coverage of the femoral head is suboptimal, increasing the likelihood of subluxation or dislocation. This aligns with the findings of this study, which showed an increased tendency toward dysplasia in individuals with higher-than-normal Acetabular Index, potentially leading to early osteoarthritis if left untreated.[8]

The mean Central Edge Angle (CEA) was 32.11°, within the normal range (20°-40°). A normal CEA indicates sufficient acetabular of the femoral head, which is essential for preventing dysplasia. However, a CEA approaching 40° can indicate a risk of FAI, a condition where excessive acetabular causes increased friction between the femoral head and acetabulum, potentially damaging cartilage.[9] In this study, most subjects had a normal CEA, indicating good hip joint stability.

The average Femoral Neck Angle of 122.63° indicates a tendency toward coxa vara, where the femoral neck angle is lower than normal (125°-135°). Coxa vara can cause uneven load distribution on the hip joint, increasing the risk of fractures and other biomechanical issues.[10] This reduction in Femoral Neck Angle increases pressure on the hip joint, which can accelerate joint degeneration or cause gait disturbances over time. Although the difference is slightly below normal, individuals with a lower femoral neck angle require special attention to prevent biomechanical complications.[11]

Hip Joint Space was measured in three parameters: superior (4.61 mm), medial (5.17 mm), and axial (8.91 mm), indicating that most subjects still had healthy joint cartilage. Healthy joint cartilage is characterized by a sufficiently wide joint space, suggesting no significant cartilage degradation. The normal hip joint space does not exceed 6 mm superiorly, 7 mm axially, or 13 mm medially.[12] The maintained Hip Joint Space suggests that the subjects in this study did not show early signs of osteoarthritis, although individuals with slightly narrowed joint spaces may require further monitoring.

The average Teardrop Distance of 6.86 mm was also within the normal range (6-11mm). Teardrop Distance is a crucial indicator of potential joint space narrowing or hip dysplasia.13 With an average value, this result suggests that most subjects in this study had healthy joint structures and no significant narrowing, which is often associated with joint degeneration.

The average Tönnis Angle of 5.10° was within the normal range (0°-10°). This angle measures the inclination of the acetabular roof and is an essential indicator of hip dysplasia.14 A Tönnis Angle greater than 10° indicates a higher risk of hip dysplasia, which can lead to joint instability and potential femoral head subluxation.[15] However, with a mean value of 5.10°, most subjects in this study had normal acetabular inclination and a low risk of dysplasia.

This study's findings indicate that most subjects had normal hip anatomy. However, some indicators warrant further attention, such as the slightly elevated Acetabular Index and the lower-than-normal Femoral Neck Angle. These findings are consistent with previous studies showing that an increased Acetabular Index can increase the risk of dysplasia. At the same time, a lower Femoral Neck Angle indicates coxa vara, which can lead to long-term biomechanical issues. Subjects with measurements approaching abnormal limits require monitoring to prevent further complications, such as osteoarthritis or hip joint instability.

CONCLUSION

Based on the data from the charts, this study concluded that all 200 subjects exhibited an Acetabular Index above 33°, indicating a consistent risk of hip dysplasia. Most subjects (125) had a Central Edge Angle (CEA) between 30°-40°, demonstrating good acetabular coverage. However, all subjects had a Femoral Neck Angle (FNA) below 125°, indicating a tendency toward coxa vara, which may increase the risk of biomechanical issues. Regarding the Hip Joint Space, all subjects had a superior space within the normal range of 3-6 mm, and most had medial and axial joint spaces that suggested healthy cartilage. The Teardrop Distance was average in 105 subjects (6-11 mm), indicating no significant joint space narrowing. Lastly, the Tönnis Angle was within normal limits for all subjects, with values between 5°-10° in half of the cases, indicating a low risk of severe hip abnormalities. The findings highlight potential biomechanical risks, particularly related to dysplasia and coxa vara, requiring careful monitoring in affected individuals.

REFERENCES

1. Vandenbussche E, Saffarini M, Taillieu F, Mutschler C. The asymmetric profile of the acetabulum. Clin Orthop Relat Res. 2008;466(2):417-23.
2. Masłoń A, Sibinski M, Topol M, Krajewski K, Grzegorzewski A. Development of human hip joint in the second and third trimester of pregnancy: a cadaveric study. BMC Dev Biol. 2013;13:19. https://doi.org/10.1186/1471-213X-13-19
3. Walker JM, Goldsmith CH. Morphometric study of the fetal development of the human hip joint: significance for congenital hip disease. J Anat. 1981;133(Pt 4):77-87.
4. Duan Z, Wu YB, Tang H, Ma J, Zhu X. An analysis of factors affecting flowslide deposit morphology using Taguchi method. Adv Civ Eng. 2020;2020:8844722. https://doi.org/10.1155/2020/8844722
5. Khan JM, Banday MI, Muzaffar J. A study of measurement of acetabular diameter radiologically in northern Indian population of Jammu region. Int J Orthop Sci. 2018;4(3.1):78-81. https://doi.org/10.22271/ortho.2018.v4.i3b.16
6. Nicholls A, Kiran A, Pollard TCB, Hart D, Arden CP, Spector TD, et al. The association between hip morphology parameters and nineteen-year risk of end-stage osteoarthritis of the hip: a nested case–control study. Arthritis Rheum. 2011;63(11):3392-400. https://doi.org/10.1002/art.3052
7. Schwabe P, Krupinski M, Kruppa C. The impact of acetabular morphology on the biomechanics of hip dysplasia: a review. J Orthop Res. 2019;37(5):1067-75. https://doi.org/10.1002/jor.24203
8. Sachdeva K, Singla RK, Kalsey G, Sharma P. Sex differences in morphometry of North Indian acetabula: forensic and orthopedic consideration. Natl J Clin Anat. 2019;8(4):153-9. https://doi.org/10.1055/s-0039-3400840
9. Domb BG, LaReau JM, Hammarstedt JE. Clinical presentation of femoroacetabular impingement. Am J Sports Med. 2016;44(1):70-7. https://doi.org/10.1177/0363546515617255
10. Chua YP, Stender M, Naidoo P, Khan WS. Biomechanics of coxa vara and its surgical implications: a systematic review. J Orthop Surg (Hong Kong). 2020;28(3):1-9. https://doi.org/10.1177/2309499020927890
11. Boese CK, Jostmeier J, Oppermann J, et al. The neck shaft angle: CT reference values of 800 adult hips. Skeletal Radiol. 2016;45:455-63. https://doi.org/10.1007/s00256-015-2314-2
12. Hayashi D, Roemer FW, Guermazi A. Imaging of osteoarthritis of the hip. Curr Rheumatol Rep. 2021;23(5):27. https://doi.org/10.1007/s11926-021-00991-x

13. Kumar D, Giori NJ, Lane NE. Teardrop distance and acetabular morphology in hip dysplasia: a retrospective analysis. J Bone Joint Surg Am. 2018;100(4):235-41. https://doi.org/10.2106/JBJS.17.00148
14. Nepple JJ, Vigdorchik JM, Clohisy JC, Sierra RJ. Acetabular morphology in developmental dysplasia of the hip. J Bone Joint Surg Am. 2015;97(7):607-15. https://doi.org/10.2106/JBJS.N.00801
15. Proenca AL. Adult hip radiography: lines and angles. https://doi.org/10.1594/essr2017/p-0209