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Original Research Article

DIAGNOSTIC ACCURACY OF X-RAY IN DIAGNOSING AVASCULAR FEMORAL HEAD, KEEPING MAGNETIC RESONANCE IMAGING (MRI) AS GOLD STANDARD

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Abstract: *Avascular necrosis of the femoral head is a common cause of musculoskeletal disability, and it presents a significant diagnostic and therapeutic challenge. Although patients are initially asymptomatic, avascular necrosis frequently leads to joint destruction, typically before the age of 50. Magnetic Resonance Imaging (MRI) is a non-invasive, rapid, and compassionate diagnostic tool commonly used by clinicians. This study aims to determine the diagnostic accuracy of X-rays in detecting avascular necrosis of the femoral head, using MRI as the gold standard. This Cross-Sectional Validation Study was conducted at the Department of Radiology, JPMC, Karachi, Pakistan. The study was conducted over six months after the synopsis approval, from November 6, 2021, to May 5, 2022. This study included all patients who met the inclusion criteria and visited the JPMC Hospital in Karachi. After explaining the procedure, risks, and benefits of the study, informed consent was obtained from all patients. All patients underwent X-rays, and those diagnosed with avascular necrosis of the femoral head underwent MRI. The collected data was entered into the attached proforma and used electronically for research. The mean age was 48.8±9.2, with 92 (63.0%) male and 54 (37.0%) female patients. The diagnostic accuracy of the X-ray was 82.88% in detecting avascular necrosis of the femoral head, with sensitivity and specificity of 82.05% and 83.82%, respectively. The positive predictive value (PPV) was 53.42%, and the negative predictive value (NPV) was 80.28%, using MRI findings as the gold standard. In conclusion, the use of X-ray in evaluating avascular necrosis of the femoral head was not helpful and comparable to MRI. Therefore, an MRI should be performed in every case of avascular necrosis of the femoral head to achieve an accurate diagnosis. More prospective and well-controlled trials are required to validate the current findings.*

Keywords: Avascular Necrosis, Diagnostic Accuracy, Femoral Head, MRI

Introduction

Osteonecrosis of the femoral head, also known as Avascular Necrosis of Femur Head (ANFH), is a pathologic condition initially observed in the femur's weight-bearing region (Guerado and Caso, 2016). If the stress is not addressed promptly, it can result in a microfracture of the bone trabecular structure, impair femur repair, and cause the femur to collapse and deform (Kapur, 2016). ANFH is caused by a disruption in the blood flow to the bone, which can have numerous etiological reasons and ultimately culminate in ischemia necrosis (Pijnenburg et al., 2019). ANFH can be further subdivided into steroid-induced and alcoholic non-traumatic ANFH, and so on. ANFH can also be classified as traumatic and non-traumatic. Early ANFH treatment may help the illness recover promptly. But in its latter stages, it causes femur collapse, hip dysfunction, and an evil consequence that lowers quality of life. Consequently, it is crucial to diagnose ANFH as soon as possible (Cohen-Rosenblum and Cui, 2019; Zhang et al., 2018).

Several distinct techniques, including MRI, SPECT, CT, X-ray, DSA, and laser Doppler, have been suggested to identify ANFH early (Ando et al., 2017; Graham, 2017). When diagnosing FHAVN, X-ray examinations are still considered the cornerstone and first-line imaging method. Examining the femoral head radiographically is also affordable and practical. Even though imaging is insensitive in the early stages of the disease, it is frequently typical in later stages and can eliminate the need for further radiologic assessment (Ando et al., 2017). Plain films in the frontal eight and lateral "frog leg" projections are required to improve diagnostic accuracy (Sandip, 2015). The sensitivity and specificity ranges of X-ray for avascular necrosis of the femoral head were 76–89 percent and 77–97 percent, respectively, in research by Chee CG et al. The prevalence of avascular necrosis of the femoral head was 52.49 percent (Chee et al., 2019).

One kind of osteonecrosis brought on by a disturbance in the blood supply to the proximal femur is avascular necrosis of the femoral head. In the United States alone, 10,000 and 20,000 new cases are recorded annually (Petek et al., 2019). It can arise from a multitude of sources, both traumatic and non-traumatic. Among many other things, these causes include coagulopathy, hereditary causes, prolonged use of steroids, prolonged alcohol use, fractures, and dislocations. Healthcare practitioners must be on the lookout for the debilitating disease known as avascular necrosis of the femoral head, a severe condition. A review of the etiology

and management, as well as relevant clinical pearls, will be provided via this activity.
I have chosen to conduct this study to ascertain the diagnostic accuracy of X-rays in diagnosing avascular necrosis of the femoral head, keeping magnetic resonance imaging (MRI) as the gold standard. After searching the literature, I found very little information regarding the diagnostic accuracy of X-rays for avascular necrosis of the femoral head. There was no local study in this area. My research will contribute to the body of knowledge in the field. My research will offer more recent data regarding its clinical implications and a way to avoid MRIs, which are costly and out of reach for the bulk of our people because of their low socioeconomic standing. Therefore, using magnetic resonance imaging (MRI) as the gold standard, the study's goal was to ascertain the diagnostic accuracy of X-ray in identifying avascular necrosis of the femoral head.

Methodology

Between November 6, 2021, and May 5, 2022, a cross-sectional study was carried out at the Radiology Department of the Jinnah Postgraduate Medical Centre (JPMC) in Karachi. The study aimed to ascertain the sensitivity and specificity of X-rays in identifying femoral head avascular necrosis. Based on a 95 percent confidence level, a 52.49 percent frequency of femoral head avascular necrosis, and intended accuracy levels of 76 percent for sensitivity and 77 percent for specificity, the sample size of 146 cases was determined.
The study included participants who met predetermined criteria and used successive sampling, which is not probability-based. Patients of both genders between the ages of 40 and 70, with symptoms lasting longer than a month and probable avascular necrosis of the femoral head, were included. Individuals who had undergone treatment for avascular necrosis of the femoral head had a history of traumatic fractures, had a chronic renal failure (defined as a creatinine level higher than 1.5 mg/dl), had a cardiac pacemaker, or showed signs of claustrophobia based on their medical history was not included in the study.
One hundred two patients who met the inclusion criteria and were sent to the Radiology department of JPMC, Karachi, were chosen after receiving approval from the institutional ethical review committee. A consultant radiologist observed the results of X-rays taken in frontal and lateral "frog leg" projections (with at least three years of post-fellowship experience). The afflicted hip joint was then subjected to magnetic resonance imaging (MRI) using a 1.5 Tesla MR equipped with SE T1W1, FS T2W1, and STIR. One consultant radiologist (with at least three years of post-fellowship experience) evaluated the MRI results and determined if the femoral head had avascular necrosis, as defined by surgery. The results of the MRI and X-ray were then compared. All the information (gender, age, BMI, type of employment (office, field, or domestic), residence (rural vs. urban), length of symptoms, and presence or absence of avascular necrosis of the femoral head on both the MRI and X-ray) was entered into a Performa that was specially made for this purpose.
Software called SPSS 25.0 was used to examine the data that had been gathered. The mean and SD for age, BMI, and symptom duration were displayed. The frequency and percentage of avascular necrosis of the femoral head on X-ray and MRI, gender, occupation (office/field/domestic), and place of residence (rural/urban) were reported. Using magnetic resonance imaging (MRI) as the gold standard, a 2x2 contingency table was utilized to determine the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of X-ray in identifying avascular necrosis of the femoral head. Age, gender, and illness duration were stratified, and diagnosis accuracy was computed after stratification.

Results

In this study, 146 patients were included to assess the diagnostic accuracy of X-rays in diagnosing avascular necrosis of the femoral head, with magnetic resonance imaging (MRI) considered the gold standard. The results were analyzed, revealing a mean age of 48.8 ± 9.2 years with a 95% confidence interval (C.I) of 47.37 to 50.39. The participants' body mass index (BMI) was assessed, revealing a mean BMI of 27.2 kg/m² with a standard deviation of 5.4. The 95% confidence interval for BMI was determined to be 26.31 to 28.08. The BMI ranged from a minimum of 16 to a maximum of 36, resulting in a range of 20. The duration of symptoms was analyzed, yielding a mean duration of 7.3 months with a standard deviation of 2.2. The 95% confidence interval for the duration of symptoms was calculated to be 6.94 to 7.65 months. The observed range for symptom duration spanned from a minimum of 2 months to a maximum of 12 months, resulting in a range of 10 (Table 1).
In the gender distribution, 92 (63.0%) patients were male, while 54 (37.0%) were female, as illustrated in Figure 1. Regarding occupational status, 78 (53.4%) patients were office workers, 42 (28.8%) were engaged in field-related occupations, and 26 (17.8%) had domestic occupational status, as depicted in figure 2. Out of the 146 patients, 96 (65.8%) were residents of urban areas, while 50 (34.2%) resided in rural areas, as shown in figure 3. On X-ray findings, avascular necrosis of the femoral head was noted in 105 (71.9%) patients. It was diagnosed in 78 (53.4%) patients on MRI findings, as shown in figure 4.

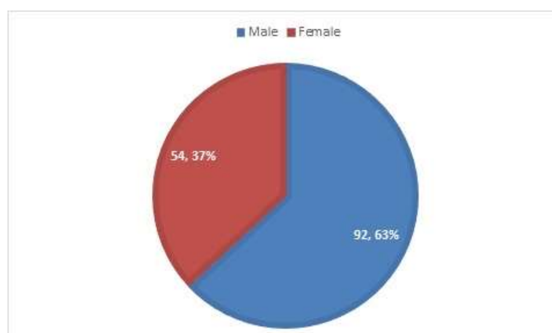

Figure 1: Patient distribution based on Gender.

In this diagnostic comparison between X-ray and MRI (Gold Standard), table 2 illustrates the number of cases in which each modality correctly or incorrectly identified the presence or absence of a condition. The values are as follows: True Positive (a) = 64, False Positive (b) = 11, False Negative (c) = 14, True Negative (d) = 57. The total number of cases where the condition was present (a + c) is

78, and the total number of cases where the condition was absent (b + d) is 68. This table helps assess the diagnostic accuracy of X-ray compared to the gold standard MRI, providing insights into true positives, false positives, false negatives, and true negatives.

In assessing the diagnostic performance of a medical test, the 95% confidence intervals for various measures provide an understanding of the precision of the estimates (table 3). For the given test, the sensitivity, representing the proportion of true positives among those with the condition (a / (a + c)), is estimated to be 82.05%, with a confidence interval ranging from 73.53% to 90.57%. Specificity, reflecting the proportion of true negatives among those without the condition (d / (b + d)), is estimated at 83.82%, with a confidence interval between 75.07% and 92.58%. The prevalence of the disease, calculated as (a + c) / (a + b + c + d), is 53.42%, with a confidence interval from 45.33% to 61.52%. Positive predictive value, indicating the probability of true positives among all positive results (a / (a + b)), is estimated at 85.33%, with a confidence interval from 77.33% to 93.34%. The negative predictive value, representing the probability of true negatives among all negative results (d / (c + d)), is 80.28%, with a confidence interval ranging from 71.03% to 89.54%. The overall accuracy of the test, computed as (a + d) / (a + b + c + d), is 82.88%, with a confidence interval between 76.77% and 88.99%. These confidence intervals provide a range within which the actual values of these diagnostic measures are likely to fall, enhancing the interpretation of the test's reliability.

Table 4 outlines the diagnostic performance of MRI across different age groups. In the age group 30-50 (n=93), the MRI test exhibits a sensitivity of 85.11% (a/(a+c)), indicating its capability to identify individuals with the condition correctly. Specificity is 80.43% (d/(b+d)), representing the accuracy of the test in correctly identifying those without the condition. The prevalence of the disease in this age group is 50.54% (a+c)/(a+b+c+d). Positive Predictive Value (PPV), indicating the probability of true positives among positive results, is 81.63% (a/(a+b)), and Negative Predictive Value (NPV), representing the probability of true negatives among negative results, is 84.09% (d/(c+d)). The overall accuracy of the test is 82.80% ((a+d)/(a+b+c+d)).

For the age group >50 (n=53), the sensitivity of the MRI test is 77.42%, the specificity is 90.91%, and the prevalence of the disease is 58.49%. PPV is 92.31%, NPV is 74.07%, and the overall accuracy is 83.02%. These values provide insights into the performance of the MRI test across different age categories, facilitating a comprehensive understanding of its diagnostic capabilities in varied demographic groups.

For the male gender group (n=92), the diagnostic performance of MRI in diagnosing avascular necrosis of the femoral head was evaluated, yielding a sensitivity of 83.33% (table 7), specificity of 93.18%, prevalence of disease at 52.17%, positive predictive value at 93.02%, negative predictive value at 83.67%, and overall accuracy of 88.04%. The 95% confidence intervals for these measures ranged from 72.79% to 93.88% for sensitivity, 85.73% to 100.63% for specificity, 41.97% to 62.38% for prevalence of disease, 85.41% to 100.64% for positive predictive value, 73.32% to 94.02% for negative predictive value, and 81.41% to 94.67% for overall accuracy. Similarly, for the female gender group (n=54), the diagnostic measures were determined with the following results: sensitivity of 80.65%, specificity of 66.67%, prevalence of disease at 56.36%, positive predictive value at 75.76%, negative predictive value at 72.73%, and overall accuracy of 74.55%. The 95% confidence intervals for these measures ranged from 66.74% to 94.55% for sensitivity, 47.81% to 85.53% for specificity, 43.26% to 69.47% for prevalence of disease, 61.14% to 90.38% for positive predictive value, 54.12% to 91.34% for negative predictive value, and 63.03% to 86.06% for overall accuracy.

Table 1: Demographic and Clinical Characteristics

Characteristic	Mean	Std Dev	95% CI Age	Min Age	Max Age	Range Age
Age (Years)	48.8	9.2	47.37 - 50.39	40	70	30
BMI (kg/m²)	27.2	5.4	26.31 - 28.08	16	36	20
Duration of Symptoms (Months)	7.3	2.2	6.94 - 7.65	2	12	10

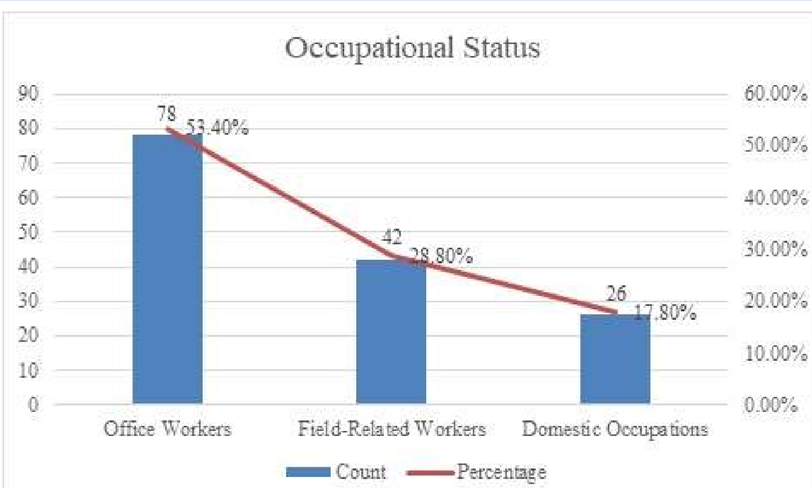

Figure 2: Patient distribution based on Occupational Status

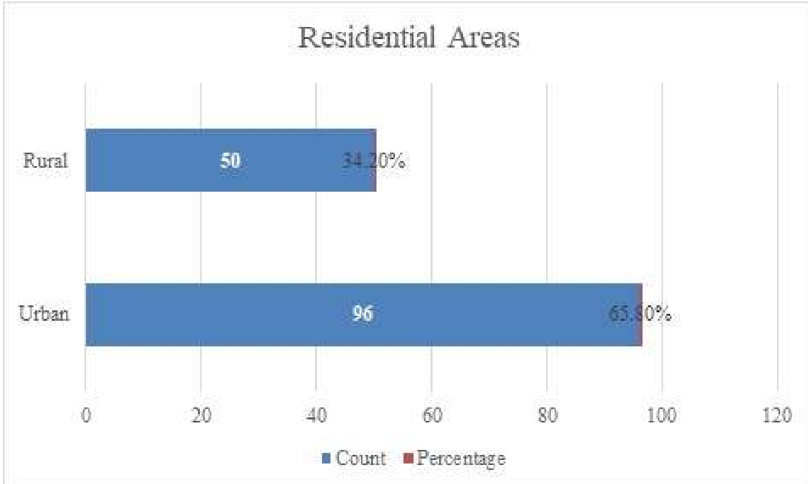

Figure 3: Patient distribution based on Residential Areas

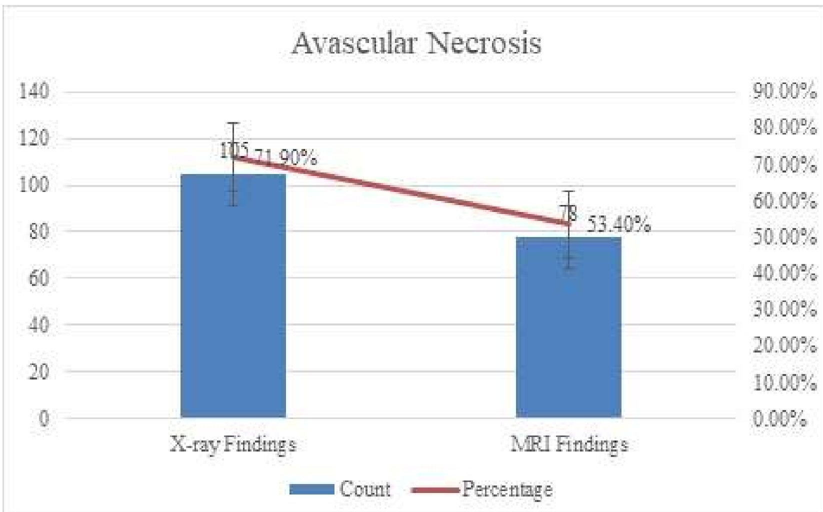

Figure 4: Diagnostic Findings

Table 2: X-Ray Vs. MRI Diagnostic Accuracy

X-RAY	MRI (Gold Standard)	
	PRESENT	ABSENT
PRESENT	True Positive (a) 64	False Positive (b) 11
ABSENT	False Negative (c) 14	True Negative (d) 57
Total	a + c 78	b + d 68

Table 3: Diagnostic performance with 95% confidence intervals

Diagnostic Measure	Formula	Point Estimate	Lower Limit	Upper Limit
Sensitivity	a / (a + c)	82.05%	73.53%	90.57%
Specificity	d / (b + d)	83.82%	75.07%	92.58%
Prevalence of Disease	(a + c) / (a + b + c + d)	53.42%	45.33%	61.52%
Positive Predictive Value	a / (a + b)	85.33%	77.33%	93.34%
Negative Predictive Value	d / (c + d)	80.28%	71.03%	89.54%
Overall Accuracy	(a + d) / (a + b + c + d)	82.88%	76.77%	88.99%

Table 4: Diagnostic Performance of MRI Across Age Groups

Age Group (Years)	MRI (Gold Standard)	
	Present	Absent
30 - 50 (n=93)		
MRI	True Positive (a) 40	False Positive (b) 9
	False Negative (c) 7	True Negative (d) 37
> 50 (n=53)		
MRI	True Positive (a) 24	False Positive (b) 2
	False Negative (c) 7	True Negative (d) 20

Table 5: Diagnostic Performance of MRI Across Age Groups with 95% Confidence Intervals

For age group 30---50 (n=93)			95% Confidence Interval	
	Formula	Point Estimate	Lower	Upper
Sensitivity	a/ (a + c)	85.11%	74.93%	95.28%
Specificity	d/ (b + d)	80.43%	68.97%	91.9%
Prevalence of disease	(a+ c)/ (a+ b+ c+ d)	50.54%	40.38%	60.7%
Positive Predictive value	a/ (a +b)	81.63%	70.79%	92.47%
Negative Predictive value	d/ (c+ d)	84.09%	73.28%	94.9%
Overall accuracy	(a+ d)/ (a+ b+ c+ d)	8.28%	75.12%	90.47%
For age group > 50 (n=53)				
	Formula	Point Estimate	Lower	Upper
Sensitivity	a/ (a + c)	77.42%	62.7%	92.14%
Specificity	d/ (b + d)	90.91%	78.9%	02.92%
Prevalence of disease	(a+ c)/ (a+ b+ c+ d)	58.49%	45.22%	71.76%
Positive Predictive value	a/ (a +b)	92.31%	82.06%	02.55%
Negative Predictive value	d/ (c+ d)	74.07%	57.54%	90.6%
Overall accuracy	(a+ d)/ (a+ b+ c+ d)	83.02%	72.91%	93.13%

Table 6: Stratification of gender concerning x-ray with 95% confidence interval

For gender male (n=92)		95% confidence interval	
	Point Estimate	Lower	Upper
Sensitivity	83.33%	72.79%	93.88%
Specificity	93.18%	85.73%	99.63%
Prevalence of disease	52.17%	41.97%	62.38%
Positive Predictive value	93.02%	85.41%	99.64%
Negative Predictive value	83.67%	73.32%	94.02%
Overall accuracy	88.04%	81.41%	94.67%
For gender female (n=54)			
		Lower	Upper
Sensitivity	80.65%	66.74%	94.55%
Specificity	66.67%	47.81%	85.53%
Prevalence of disease	56.36%	43.26%	69.47%
Positive Predictive value	75.76%	61.14%	90.38%
Negative Predictive value	72.73%	54.12%	91.34%
Overall accuracy	74.55%	63.03%	86.06%

Table 7: Stratification for the duration of symptoms concerning x-ray with 95% Confidence Interval (n=146)

For the duration of symptoms 02---06 (n=61)		**95% Confidence Interval**	
	Point Estimate	Lower	Upper
Sensitivity	80.00%	65.69%	0.9431
Specificity	83.87%	70.92%	0.9682
Prevalence of disease	49.18%	36.63%	0.6173
Positive Predictive value	82.76%	69.01%	0.9651
Negative Predictive value	81.25%	67.73%	0.9477
Overall accuracy	0.8197	0.7232	0.9162
FOR DURATION OF SYMPTOMS >06 (n=85)			
		Lower	Upper
Sensitivity	83.33%	72.79%	93.88%
Specificity	83.78%	71.91%	95.66%
Prevalence of disease	56.47%	45.93%	67.01%
Positive Predictive value	86.96%	77.22%	96.69%
Negative Predictive value	79.49%	66.81%	92.16%
Overall accuracy	83.53%	75.64%	91.41%

Discussion

When diagnosing FHAVN, X-ray examinations are still considered the cornerstone and first-line imaging method. Examining the femoral head radiographically is also affordable and practical. Imaging characteristics of more advanced stages of the disease are generally characteristic. They may eliminate the need for further radiologic evaluation, even though they are insensitive early. Plain films in both lateral and frontal "frog leg" projections are required to improve diagnosis accuracy. A femoral head may be expected up to three months after the start of the illness. Areas of sclerosis within the femoral head, the presence of radiolucent lines (a "crescent sign") consistent with subchondral fracture and collapse of the cortex with flattening of the femoral head, and eventual lateral subluxation are typical features that appear in order from early to late-stage disease. Cystic lesions are sometimes seen in conjunction with sclerotic regions and are considered a poor prognostic feature that indicates the likelihood of a collapse in the future. The most recent developments in the range of diseases include osteoarthritis and ankylosis (Gross and Liu, 2011). In 18% of cases and patients receiving steroid medication, atypical radiographic characteristics are found (Aiello and Chew, 2012). In this population, joint space narrowing is common and typically occurs before the crescent sign appears.

Additionally, in the context of normal bone resorption, bone production may decrease, leading to the absence of symptoms of bone repair such as sclerosis. The diagnosis of FHAVN can be made confidently in typical radiographic findings between it and osteoarthritis or rapid onset osteoarthritis, where osteophytes and joint space narrowing are predominant. However, in atypical presentations, the diagnosis may be more subtle and is typically initiated by the clinician's index of suspicion and confirmed by second-line investigations (Pivec et al., 2013). Lesion extension has also been assessed using plain films; according to the ARCO classification, it is classified as mild, moderate, or severe depending on whether it affects less than 15%, 15% to 30%, or more than 30% of the femoral head, respectively. Anteroposterior and lateral radiography have been subjected to several methodical measurements. Niimi et al. (Niimi et al., 2008) specifically looked at the percentage of the weight-bearing area affected by the disease and identified four types of lesions on AP radiographs. Bedi et al. (Bedi et al., 2011) measured the arc of the femoral surface by drawing two lines from the center to the periphery of the affected femoral head on both AP and lateral radiographs, considering two different angles. A recent diagnostic method (Pierce et al., 2015) states that no additional imaging is necessary if radiography demonstrates morphological alterations of the femoral head, specifically if there is a depression of the articular surface between 2 and 4 mm that may or may not be related to acetabular changes. When areas of sclerosis are connected to lucency lines of questionable importance, a second CT scan may be ordered to rule out subchondral fractures. Conversely, conventional radiography might not be as sensitive and precise as more sophisticated methods, which can detect early stages in asymptomatic people but are still crucial in the later stages (Hong et al., 2005; Niimi et al., 2008; Pierce et al., 2015).

With a sensitivity above 99 percent, MRI is regarded as the gold standard method in the early stages of FHAVN; as a result, both the Steinberg and ARCO classifications include this method in the early disease stage (Kamata et al., 2008; Ozel et al., 2016; Piyakunmala et al., 2009). In animals, signal alterations in the bone marrow have been shown to occur one week after vascular injury. The diagnostic MRI protocols include Axial T2 FSE, coronal and axial PD, sagittal T1 fast spin echo (FSE), and Short Tau Inversion Recovery (STIR) sequences. Depending on the various performing centers, post-operative scans may contain T2 Spectral Adiabatic Inversion Recovery (SPAIR) sequences less affected by metallic artifacts. Although it could show a ring enhancement from the granulation tissue at the lesion's edge or no enhancement in the necrotic area, diagnostic post-contrast imaging is typically not done. In T1 weighted images, the osteonecrosis area is bounded by a hypointensity resembling a "band" corresponding to the rim of reacting sclerosis encircling the affected bone marrow (Barile et al., 2014; Malizos et al., 2007; Stevens et al., 2003; Yeh et al., 2009; Zhao and Hu, 2012). Depending on the extent of the FHAVN, wedge, ring-like, crescent-shaped, and serpentine lesions are also frequent. In a small percentage of instances, the area of necrosis may exhibit distinct signal intensities from bone marrow adipose tissue because of the eventual hemorrhagic, cystic, or fibrous progression, according to Mitchell et al. (Mitchell et al., 1987). The "double line" sign on T2 weighted images, which is thought to be a chemical shift artifact in its origin and is characterized by an inner zone of high intensity referred to as the granulation tissue and an outer low signal of intensity rim, is another pathognomonic alteration that is visible in 65–85% of patients (Barile et al., 2014). Subchondral fractures can be distinguished from insufficiency fractures, which have an uneven form and are convex to the surface by their smooth, low signal intensity lines concave to the articular surface on T1-weighted images. Because fluid collections or gas may eventually form in the fracture gap, multiple signal intensities may be seen on T2-weighted images. Bone Marrow Edema (BME) can affect only the epiphysis or spread to the metaphysis. It is often clearly documented at T2 fat-suppressed weighted imaging. Numerous studies have examined its potential function as a first indicator of FHAVN and its correlation with subchondral fracture, symptoms, and outcome (Douglas-Akinwande et al., 2006; Mitchell et al., 1987). At least 50% of patients with FHAVN also have BME in addition to joint effusion.

Conventional magnetic resonance imaging examinations can also detect morphologic alterations of the femoral head, such as collapse and contour alteration. It is also feasible to quantify the degree of osteonecrosis, and this measurement is thought to include crucial information on prognosis. Several techniques have been put out for this purpose, but the most reliable indicator of future collapse is believed to be the total volume of the femoral head. Of the patients, 43–87 percent experience articular collapse when more than 25–50 percent of the femoral head is involved, but only 5 percent of those with less than 25 percent involvement may experience future deformity (Dasa et al., 2008; Huang et al., 2003; Nam et al., 2008). Even though there is no place for lesion follow-up following head collapse, several authors have lately highlighted the potential use of MRI for tiny pre-collapse lesions that may eventually be cured with conservative therapy (Lieberman et al., 2003; Murphey et al., 2014; Zhao et al., 2010). Kerimaa et al. (Kerimaa et al., 2016) have advocated the intra-operative use of MRI after using it to guide femoral head core decompression. The procedure's technical success rate was 100%, comparable to the advantage of showing the parts of the femoral head that are most afflicted and acquiring images in any plane. Additionally, MRI may be utilized to evaluate surgery results, especially in patients with vascularized fibrillar grafting (VFG) (Lieberman et al., 2003; Murphey et al., 2014; Nam et al., 2008). In the event of VFG, gadolinium injection may provide crucial prognostic information, even though it is not usually done during the post-operative phase unless there is a suspicion of infection. An increase around the graft and necrotic area indicates revascularization. This is frequently linked to a decrease in BME, showing a positive result (Buchan et al., 2012; Elias et al., 2007). In conclusion, when plain films are harmful in the early stages, conventional MRI is regarded as the gold standard method and can guide and monitor FHAVN conservative and surgical treatments.

The average age in our study was 48.8±9.2 years. The mean age was 45, according to the survey by Banuprakash et al. (Bhanuprakash et al., 2018). The mean age was 47±15 years, according to Chee et al. (Chee et al., 2019), but 49.20±2.0 years according to Mohey et al. (Mohey and Hassan, 2020). 54 (37 percent) of the patients in this study were female, and 92 (63 percent) were male. Twelve (34.3%) of the participants in the survey by Banuprakash S. et al. were men, while twenty-three (65.7%) were women [38]. While Mohey et al. [40] report 65.5 percent men and 37.5 percent females, Chee et al. [39] reported 242 (60.2 percent) males and 160 (39.8 percent) females. Using MRI results as the gold standard, the current study found that the diagnostic accuracy of an X-ray was 82.88 percent in the diagnosis of avascular necrosis of the femoral head, with sensitivity being 82.05 percent, specificity being 83.82 percent, PPV being 53.42 percent, and NPV being 80.28 percent. According to Zhang et al.'s (Zhang et al., 2018) study, global sensitivity and specificity of MRI in early osteonecrosis of the femoral head were 93 percent and 91 percent, respectively. Chee et al. study .'s (Chee et al., 2019) reported that X-ray sensitivity and specificity on magnetic radiography images were 76–89 percent and 77–97 percent, respectively, in diagnosing avascular necrosis of the femoral head.

Conclusion

In this Cross-Sectional Validation Study conducted at the Department of Radiology, JPMC, Karachi, the diagnostic accuracy of X-ray in identifying avascular necrosis of the femoral head was assessed against the gold standard MRI. Despite a diagnostic accuracy of 82.88% for X-ray, the sensitivity and specificity were 82.05% and 83.82%, respectively. The study concluded that X-ray evaluation alone may not be sufficient for accurate diagnosis, emphasizing the importance of incorporating MRI in assessing avascular necrosis of the femoral head. Further prospective and well-controlled trials are recommended to validate these findings and enhance diagnostic precision.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned.

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

FARIDA ZAFAR SHAKIR (Consultant)
Data entry and Data analysis, drafting article
RADHA MELWANI (Consultant)
Coordination of collaborative efforts.
Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript
SANA MANSOOR (Consultant)
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SAIMA FAHIM (FCPS)
Manuscript revisions, critical input.
Coordination of collaborative efforts.
KIRAN KUMARI (FCPS)
Coordination of collaborative efforts
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Data acquisition, analysis.
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