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Morphological And Morphometric Characteristics Of The Hip Joint In Post-Traumatic Coxarthrosis

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Abstract

Post-traumatic coxarthrosis is a chronic degenerative condition of the hip joint that arises as a consequence of previous traumatic injury and is characterized by progressive structural deterioration and functional impairment. The condition remains a significant concern in orthopedic practice due to its impact on patient mobility and quality of life. The present study aims to provide a comprehensive evaluation of morphological and morphometric changes in the hip joint associated with post-traumatic coxarthrosis.

A descriptive cross-sectional study design was applied, involving patients with a confirmed history of hip joint trauma followed by clinical and radiographic manifestations of coxarthrosis. Morphological assessment focused on qualitative structural alterations, including deformation of the femoral head, changes in the acetabular surface, and the presence of osteophytes and subchondral sclerosis. Morphometric analysis included quantitative measurements such as joint space width, femoral neck-shaft angle, and acetabular index, obtained through standard radiographic imaging techniques.

The findings demonstrated pronounced morphological abnormalities, including flattening and irregular contour of the femoral head, narrowing of the joint space, and structural remodeling of the acetabulum. Morphometric results indicated a

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consistent decrease in joint space width and significant deviations in angular parameters compared to normal anatomical values. These changes were associated with reduced joint function, increased mechanical stress, and progression of degenerative processes.

In conclusion, post-traumatic coxarthrosis involves complex and interrelated morphological and morphometric alterations that can be effectively identified through integrated radiological assessment. A detailed understanding of these changes is essential for improving early diagnosis, monitoring disease progression, and optimizing clinical management strategies.

Keywords: Post-traumatic coxarthrosis, hip joint, morphology, morphometry, joint space narrowing, femoral head deformity, acetabular changes, orthopedic pathology

Introduction

Post-traumatic coxarthrosis represents a distinct form of secondary degenerative joint disease that develops following mechanical injury to the hip joint. It commonly arises after fractures of the femoral head or neck, acetabular fractures, or traumatic dislocations, all of which disrupt the normal anatomical congruency and biomechanical stability of the joint. Unlike primary coxarthrosis, which is typically associated with age-related degeneration, post-traumatic forms often affect younger and middle-aged individuals and tend to progress more rapidly due to pre-existing structural damage.

The hip joint is a highly specialized synovial articulation designed to withstand substantial mechanical loads while maintaining a wide range of motion. Its stability depends on the precise anatomical relationship between the femoral head and the acetabulum, as well as the integrity of cartilage, subchondral bone, and surrounding soft tissues. Traumatic injury can alter these relationships, leading to uneven load distribution, increased mechanical stress, and subsequent degeneration of articular cartilage. Over time, these processes result in characteristic morphological changes, including deformation of the femoral head, acetabular remodeling, osteophyte formation, and subchondral sclerosis.

Morphological evaluation of the hip joint provides important qualitative information about structural damage, while morphometric analysis offers quantitative parameters that reflect the severity and progression of the disease.

Parameters such as joint space width, femoral neck-shaft angle, and acetabular index are widely used in clinical and radiological practice to assess joint integrity and biomechanical alignment. Changes in these indicators are closely associated with cartilage loss, joint instability, and altered load transmission across the hip joint.

Despite the recognized importance of these parameters, there remains a need for integrated studies that simultaneously assess both morphological and morphometric characteristics in patients with post-traumatic coxarthrosis. Many existing studies focus primarily on either radiological descriptions or clinical outcomes, without providing a comprehensive structural analysis of the joint. Furthermore, variability in injury mechanisms and healing patterns may lead to diverse morphological presentations, highlighting the necessity for detailed and systematic evaluation.

A thorough understanding of these structural and dimensional changes is essential for improving diagnostic accuracy, determining disease stage, and selecting appropriate therapeutic strategies. Early identification of pathological alterations may allow for timely intervention, potentially delaying disease progression and reducing the need for surgical treatment.

Therefore, the aim of the present study is to comprehensively investigate the morphological and morphometric features of the hip joint in patients with post-traumatic coxarthrosis using radiographic assessment methods.

Materials and Methods

This study was conducted as a descriptive cross-sectional investigation aimed at identifying structural and dimensional alterations of the hip joint in post-traumatic coxarthrosis. The research included 48 patients with a documented history of hip joint trauma followed by clinical and radiographic manifestations of degenerative joint disease. The study population consisted of individuals aged between 30 and 65 years, reflecting the typical age range in which post-traumatic degeneration becomes clinically significant.

Radiological assessment was performed using standardized anteroposterior pelvic radiographs obtained under controlled positioning conditions to ensure consistency of measurements. All images were analyzed digitally, allowing precise determination of both qualitative and quantitative parameters. Morphological evaluation focused on identifying structural abnormalities such as deformation of the femoral head, irregularity of the acetabular surface, osteophyte

formation, and subchondral sclerosis. These features were assessed visually and categorized based on severity.

Morphometric analysis involved a series of quantitative measurements reflecting joint integrity and biomechanical alignment. The joint space width (JSW) was measured in millimeters at the superior load-bearing zone of the hip joint. A reduction in JSW was interpreted as an indirect indicator of cartilage degeneration. The femoral neck-shaft angle (NSA) was calculated by determining the angle between the longitudinal axis of the femoral shaft and the axis of the femoral neck, providing insight into biomechanical deviations. Additionally, the acetabular index (AI) was measured to assess the inclination of the acetabulum and its contribution to joint stability.

To enhance analytical accuracy, a relative deviation index was calculated for each parameter using the formula:

Deviation (%) = [(Observed value − Normal reference value) / Normal reference value] × 100

This allowed quantification of the degree of abnormality relative to established anatomical norms. For example, a decrease in joint space width below 2 mm was considered indicative of advanced cartilage degeneration, while deviations in the neck-shaft angle exceeding ±5° from normal values suggested altered biomechanical loading.

All measurements were performed independently by two observers, and the average values were used for analysis to reduce inter-observer variability. Descriptive statistical methods were applied, and results were expressed as mean ± standard deviation. Comparative interpretation was carried out against widely accepted anatomical reference ranges to determine the extent of pathological changes.

This integrated methodological approach allowed simultaneous evaluation of both morphological alterations and morphometric deviations, providing a comprehensive understanding of structural remodeling in post-traumatic coxarthrosis.

Materials and Methods

This study was conducted as a descriptive cross-sectional investigation aimed at evaluating the morphological and morphometric characteristics of the hip joint in patients with post-traumatic coxarthrosis. The study included 48 patients with a documented history of hip joint trauma followed by clinical and radiographic

signs of degenerative changes. The age of participants ranged from 30 to 65 years, reflecting the typical population affected by post-traumatic joint degeneration.

Radiographic assessment was performed using standardized anteroposterior (AP) pelvic radiographs obtained under controlled positioning conditions to ensure consistency and reproducibility of measurements. All images were analyzed using digital radiographic software, allowing precise identification of anatomical landmarks and accurate measurement of parameters.

Morphological evaluation focused on qualitative structural alterations, including deformation of the femoral head, irregularity of the acetabular surface, presence of osteophytes, and subchondral sclerosis. These features were assessed visually and categorized according to the degree of structural damage.

Morphometric analysis was carried out using established orthopedic measurement techniques. The joint space width (JSW) was measured in millimeters at the superior weight-bearing region of the hip joint, representing cartilage thickness. The femoral neck-shaft angle (NSA) was determined by calculating the angle between the longitudinal axis of the femoral shaft and the axis of the femoral neck. The acetabular index (AI) was measured to evaluate acetabular inclination and joint stability.

To standardize the evaluation, each parameter was compared with accepted anatomical reference values. Additionally, the relative deviation from normal values was calculated using the following formula:

Deviation (%) = [(Observed value − Reference value) / Reference value] × 100

This calculation enabled quantitative assessment of the severity of structural changes.

Note. Measurement definitions and reference ranges are based on Azar et al. (2021); Standring (2020); Radiopaedia (n.d.).

Parameter	Measurement Description	Normal Range	Clinical Interpretation
Joint Space Width (JSW)	Distance between femoral head and acetabulum (mm)	3.5 – 5.0 mm	Indicator of cartilage thickness
Neck-Shaft Angle (NSA)	Angle between femoral shaft and neck axes	125° – 135°	Reflects biomechanical alignment

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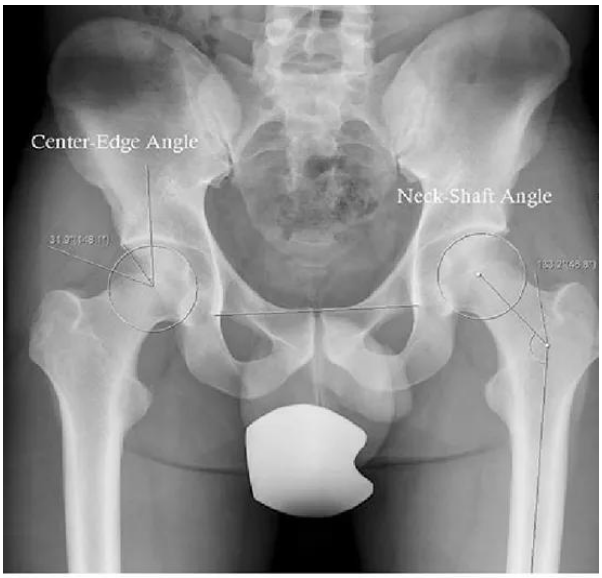
Parameter	Measurement Description	Normal Range	Clinical Interpretation
Acetabular Index (AI)	Angle of acetabular inclination	30° – 40°	Indicates joint stability

Figure 1. Radiographic measurement of hip joint parameters (NSA, JSW, AI).



Note. **Adapted from Standring (2020); Radiopaedia (n.d.); Clohisy et al. (2008).**

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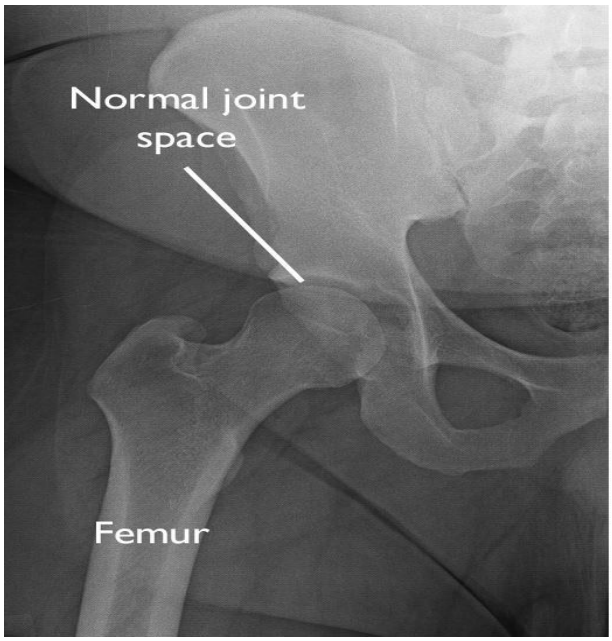

Figure description:
The figure demonstrates the standard radiographic technique used to measure key morphometric parameters of the hip joint. The joint space width (JSW), femoral neck-shaft angle (NSA), and acetabular index (AI) are illustrated on an anteroposterior pelvic radiograph, highlighting the anatomical landmarks used in measurement.

All measurements were performed independently by two observers, and the mean values were used to minimize inter-observer variability. Statistical analysis was conducted using descriptive methods, with results expressed as mean ± standard deviation.

Results

The analysis of radiographic data revealed significant morphological and morphometric alterations in the hip joints of patients with post-traumatic coxarthrosis. Structural evaluation demonstrated that the majority of patients exhibited deformation and flattening of the femoral head, along with irregularities

of the acetabular surface. Osteophyte formation and subchondral sclerosis were also frequently observed, indicating advanced degenerative changes.

Quantitative morphometric analysis showed a consistent reduction in joint space width (JSW), reflecting progressive cartilage loss. In addition, deviations in the femoral neck-shaft angle (NSA) and acetabular index (AI) were identified, suggesting altered biomechanical alignment of the hip joint.

Table 2. Morphometric characteristics of the hip joint.

Note. **Values interpreted based on Azar et al. (2021) and Browner et al. (2019).**

Parameter	Normal Range	Mean ± SD	Deviation (%)
Joint Space Width (mm)	3.5 – 5.0	1.8 ± 0.6	−48%
Neck-Shaft Angle (°)	125 – 135	118 ± 7	−7%
Acetabular Index (°)	30 – 40	44 ± 5	+10%

Note. Values are expressed as mean ± standard deviation. Deviation (%) was calculated relative to the midpoint of normal reference ranges. The mean joint space width (1.8 ± 0.6 mm) was substantially lower than normal values, indicating significant cartilage degeneration. The femoral neck-shaft angle was reduced (118° ± 7°), reflecting biomechanical alterations in femoral alignment. In contrast, the acetabular index was increased (44° ± 5°), suggesting acetabular inclination changes and reduced joint stability.

In unilateral cases, comparison with the contralateral (unaffected) hip joint revealed clear asymmetry in all measured parameters, further supporting the impact of trauma on joint structure and function.

Overall, the findings demonstrate that post-traumatic coxarthrosis is associated with pronounced structural remodeling and measurable deviations in key morphometric parameters, which correlate with disease severity and functional impairment.

Discussion

The present study provides a comprehensive evaluation of morphological and morphometric alterations in the hip joint associated with post-traumatic coxarthrosis. The findings demonstrate that structural damage following trauma leads to progressive and measurable changes in joint anatomy, which are closely linked to functional impairment and disease progression.

One of the most prominent findings of this study is the significant reduction in joint space width, which reflects advanced cartilage degeneration. This observation is consistent with established orthopedic understanding that cartilage loss is a primary indicator of osteoarthritic progression. The decrease in joint space not only signifies structural deterioration but also contributes to increased mechanical stress on subchondral bone, further accelerating degenerative processes.

In addition to cartilage-related changes, alterations in angular parameters—particularly the femoral neck-shaft angle and acetabular index—highlight the biomechanical consequences of post-traumatic joint remodeling. A reduction in the neck-shaft angle suggests varus deformity, which shifts load distribution medially and increases stress concentration within the joint. Conversely, the observed increase in the acetabular index indicates changes in acetabular orientation, potentially leading to decreased joint stability and altered articulation between the femoral head and acetabulum.

The morphological findings, including femoral head deformation, osteophyte formation, and subchondral sclerosis, further support the concept that post-traumatic coxarthrosis is characterized by complex structural remodeling. These features are not merely secondary changes but play an active role in the progression of the disease by disrupting joint congruency and impairing smooth articulation.

Importantly, the combined use of morphological and morphometric assessment in this study provides a more integrated understanding of joint pathology. While qualitative evaluation allows identification of visible structural abnormalities, quantitative measurements enable objective assessment of disease severity and progression. This dual approach enhances diagnostic accuracy and supports more informed clinical decision-making.

The findings of this study are in agreement with previous orthopedic and radiological research, which emphasizes the role of biomechanical imbalance and structural disruption in the pathogenesis of secondary osteoarthritis. However, the present study contributes additional value by systematically correlating

morphological features with measurable morphometric deviations, thereby offering a more detailed characterization of post-traumatic joint degeneration.

From a clinical perspective, these results underscore the importance of early detection and continuous monitoring of structural changes in patients with a history of hip trauma. Timely identification of morphometric deviations may allow for preventive or corrective interventions aimed at reducing disease progression and improving functional outcomes.

Despite its contributions, the study has certain limitations. The relatively limited sample size and cross-sectional design restrict the ability to establish causal relationships or evaluate long-term progression. Future research should incorporate longitudinal designs and larger patient populations to further validate these findings and explore the dynamics of post-traumatic coxarthrosis over time.

In conclusion, post-traumatic coxarthrosis is characterized by significant and interrelated morphological and morphometric alterations that reflect both structural damage and biomechanical dysfunction. A comprehensive assessment integrating these parameters is essential for accurate diagnosis, disease staging, and the development of effective treatment strategies.

Conclusion

In conclusion, post-traumatic coxarthrosis is characterized by significant morphological and morphometric alterations of the hip joint, reflecting both structural damage and biomechanical imbalance. The study demonstrates that key parameters such as joint space width, femoral neck-shaft angle, and acetabular index undergo measurable changes that correlate with the severity of degenerative processes.

The integration of qualitative morphological assessment with quantitative morphometric analysis provides a comprehensive approach to evaluating joint pathology. This combined methodology enhances diagnostic accuracy and allows for a more precise assessment of disease progression.

Early identification of these structural and dimensional changes is essential for timely clinical intervention. Accurate radiographic evaluation can support improved treatment planning, potentially slowing disease progression and preserving joint function.

Overall, a detailed understanding of hip joint morphology and morphometry in post-traumatic coxarthrosis is crucial for optimizing patient outcomes and advancing orthopedic diagnostic practices.

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