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Ulusal Travma ve Acil Cerrahi Dergisi

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Tel	+90 212 - 588 62 46
Fax *(Faks)*	+90 212 - 586 18 04

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Our journal is indexed in several prestigious databases, with the indexing history detailed below:

As of 2001, the journal has been indexed in Index Medicus / Medline and Scopus. Starting from 2005, it is included in Excerpta Medica and EMBASE. From 2007 onwards, it has been listed in the Science Citation Index Expanded (SCI-E) and the Journal Citation Reports / Science Edition. Since 2014, the journal is indexed in EBSCOhost and ProQuest. As of 2023, it has been added to PubMed Central.

The journal's impact factor in SCI-E indexed journals is 1.1 according to the 2023 Journal Citation Reports (JCR). In PubMed, the journal is cited as 'Ulus Travma Acil Cerrahi Derg'.

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Unless specifically indicated otherwise at the time of submission, rejected manuscripts will not be returned to the authors, including accompanying materials.

Priority of publications is given to original studies; therefore, selection criteria are more refined for reviews and case reports.

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The cover letter must contain a brief statement that the manuscript has been read and approved by all authors, that it has not been submitted to, or is not under consideration for publication in, another journal. It should contain the names and signatures of all authors. The cover letter is uploaded at the 10th step of the "Submit New Manuscript" section, called "Upload Your Files".

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EXPERIMENTAL STUDY

Diagnostic accuracy of oblique radiographic views for ulnar-sided carpometacarpal dislocations: A cadaveric study

Omar Aljasim,[1] Can Yener,[1] Mesut Demirkoparan,[1] Arman Vahabi,[1] Ali Engin Daştan,[1] Nadir Özkayın,[1] Okan Bilge,[2,3] Hüseyin Günay,[1] Levent Küçük[1]

[1]Department of Orthopedic Surgery, Ege University Faculty of Medicine, İzmir-*Türkiye*
[2]Department of Anatomy, Ege University Faculty of Medicine, İzmir-*Türkiye*
[3]Interventional Anatomy and Plastination Research Center, Ege University Faculty of Medicine, İzmir-*Türkiye*

ABSTRACT

BACKGROUND: Dislocations and fracture-dislocations of the ulnar-sided carpometacarpal (CMC) joints are rare injuries that are often overlooked during initial clinical evaluations, primarily due to subtle radiographic findings and overlapping anatomical structures. Missed or delayed diagnosis can result in chronic instability, persistent pain, and suboptimal functional outcomes. This study aimed to assess and compare the diagnostic sensitivity and specificity of different oblique radiographic projections in identifying fifth CMC joint dislocations using a controlled cadaveric model.

METHODS: Six human cadaveric hands, preserved with the modified Larssen solution, were used in this study. Oblique fluoroscopic images were acquired at 30°, 45°, and 60° angles from the lateral view, under three different joint conditions: Native alignment, 25% dislocation, and 50% dislocation of the fifth CMC joint. Standardized imaging was performed using a fixed digital setup. A total of 54 randomized images were included in a questionnaire reviewed by 20 orthopedic surgeons (7 consultants and 13 senior registrars), who classified the fifth CMC joint status as "dislocated," "not dislocated," or "uncertain." Sensitivity, specificity, and overall diagnostic accuracy were calculated for each oblique angle.

RESULTS: The 60° oblique radiographs exhibited the highest sensitivity for identifying dislocations but had a moderate reduction in specificity. In contrast, the 30° view showed the highest specificity but the lowest sensitivity. The 45° oblique radiographs provided a more balanced diagnostic profile. Overall, the 60° oblique radiographs achieved the greatest diagnostic accuracy. Interestingly, senior registrars demonstrated significantly higher diagnostic accuracy than consultants.

CONCLUSION: While the 60° oblique radiographs showed the best performance in detecting fifth CMC dislocations, their sensitivity was not sufficient for use as a standalone diagnostic tool. When clinical suspicion persists despite inconclusive radiographs, computed tomography scan is recommended.

Keywords: Carpometacarpal joint; dislocation; oblique radiograph.

INTRODUCTION

Dislocations and fracture-dislocations involving the carpometacarpal (CMC) joints of the ring and little fingers are relatively rare and may be missed on initial radiographic evaluation.[1] Due to their infrequency, no evidence-based diagnostic or management guidelines have been developed, and most available data are derived from case series and individual author experience.[2,3] This injury is commonly seen in young males and more frequently affects the dominant hand.

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Address for correspondence: Omar Aljasim
Department of Orthopedic Surgery, Ege University Faculty of Medicine, İzmir, Türkiye
E-mail: omar.aljasim.md@gmail.com

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[4,5] These injuries typically result from direct impact, such as a punch against a hard surface, which generates axial loading combined with a lever mechanism that causes extension or flexion of the metacarpal relative to the distal carpal row.[6,7]

The fifth CMC joint is a shallow saddle-shaped articulation with limited intrinsic stability, allowing approximately 30° of motion necessary for effective power grip.[3,8] The fifth CMC joint is supported by the dorsal and palmar CMC ligaments, the ulnar collateral ligament, the pisometacarpal ligament, the dorsal and palmar intermetacarpal ligaments, and the interosseous intermetacarpal ligament complex.[9] The fourth–fifth intermetacarpal ligament is the primary stabilizer of the fifth CMC joint.[3]

Diffuse swelling can obscure the typical clinical deformity, while conventional radiographs may be insufficient to diagnose the injury. Henderson and Arafa reviewed 21 cases of dorsal dislocation of CMC joints, of which 15 were missed during the initial evaluation in the emergency department.[10] When CMC dislocations occur alongside adjacent metacarpal fractures, the fracture may distract the examiner's attention, making the associated dislocation more difficult to detect.[11] Delayed diagnosis may result in suboptimal outcomes, as non-operative management often fails to achieve full reduction, leading to limited range of motion, diminished grip strength, persistent pain, functional impairment, and degenerative joint changes.[4]

Diagnosis and management of metacarpal head and shaft fractures are generally achievable using anteroposterior, lateral, and 30°-45° oblique radiographs (in pronation or supination).[12-14] However, fractures and fracture–dislocations involving the base of the fifth metacarpal and the fifth CMC joint remain more challenging to assess due to bony overlap. Several authors have proposed different radiographic methods to aid in the early diagnosis of this injury. These include assessing the parallelism of the M lines, alignment of articular margins, joint space symmetry, cortical contour continuity, and hand positioning.[15] Additional techniques involve drawing metacarpal cascade lines on posteroanterior radiographs, measuring the angle between the second and fifth metacarpals on true lateral views, and evaluating the capitate–metacarpal angle.[16-18] A study by Johnson et al.[19] found that a 60° oblique radiograph was the most sensitive projection for detecting fifth CMC dislocations. This study aimed to re-evaluate and validate the diagnostic sensitivity and specificity of various oblique radiographic angles in detecting fifth CMC dislocations using a cadaveric model.

MATERIALS AND METHODS

This study was approved by the Ege University Review Board (Date: 04.09.2025, Decision no: 25-9T/20). Six human cadaveric hands, preserved using the modified Larssen solution, were utilized. The cadavers had a mean age of 51 years (range: 25–60 years) and included three males and three females. All donors had no known osteomuscular disorders, and each specimen was examined to confirm the absence of CMC joint arthropathies. A dorsal longitudinal incision was made over the fifth CMC joint. Soft tissue dissection was carried out to expose the joint, with the extensor carpi ulnaris tendon retracted ulnarly. Sharp dissection was used to release all the fifth CMC ligaments, allowing complete dislocation of the fifth metacarpal base. The total sagittal width of the fifth metacarpal base was measured using a digital caliper. Reference points were marked at 25% and 50% along the dorsal aspect of the metacarpal base, where 0.8 mm drill holes were subsequently created for the placement of a radiolucent fixator (Fig. 1a and b). A digital camera (Nikon D90 model, Tokyo, Japan) was used to capture fluoroscopic images displayed on the monitor, with the camera held in a fixed position throughout the experiment. Three consecutive fluoroscopic images were obtained at 30°, 45°, and 60° oblique angles by pronating the hand incrementally from the true lateral position while the fifth CMC joint was reduced. The joint was then dislocated sequentially to the 25% and 50% positions (Fig. 2a-c). At each dislocation level, three fluoroscopic images were again captured at the same oblique angles (Fig. 3a-c). All fluoroscopic views were digitally recorded using the fixed camera setup.

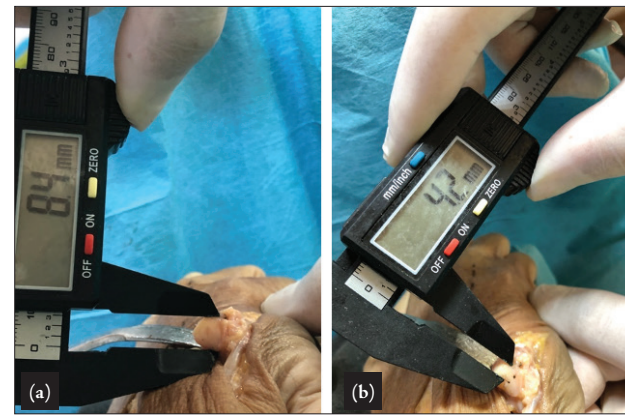


Figure 1. Dislocation of the base of the fifth metacarpal following dissection. **(a)** Measurement of the sagittal width of the fifth metacarpal base to determine the degree of dislocation. **(b)** Reference markings indicating 25% and 50% dislocation positions for guide hole placement.

Dissection, fixation, and fluoroscopic imaging were performed by three senior orthopedic residents. Subsequently, a questionnaire was created using the Google Forms platform, comprising 54 randomized fluoroscopic images. These images were presented to 20 orthopedic surgeons, including 7 orthopedic consultants (attending) and 13 senior orthopedic registrars (residents). Reviewers were instructed to focus on the fifth CMC joint in each image and classify it as either: dislocated, not dislocated, or uncertain. Responses to all images were mandatory. For the purpose of analysis, "uncertain" responses were considered incorrect. The three senior orthopedic residents who performed the experiment did not participate in the questionnaire assessment.

Data obtained in the study were analyzed using the Statisti-

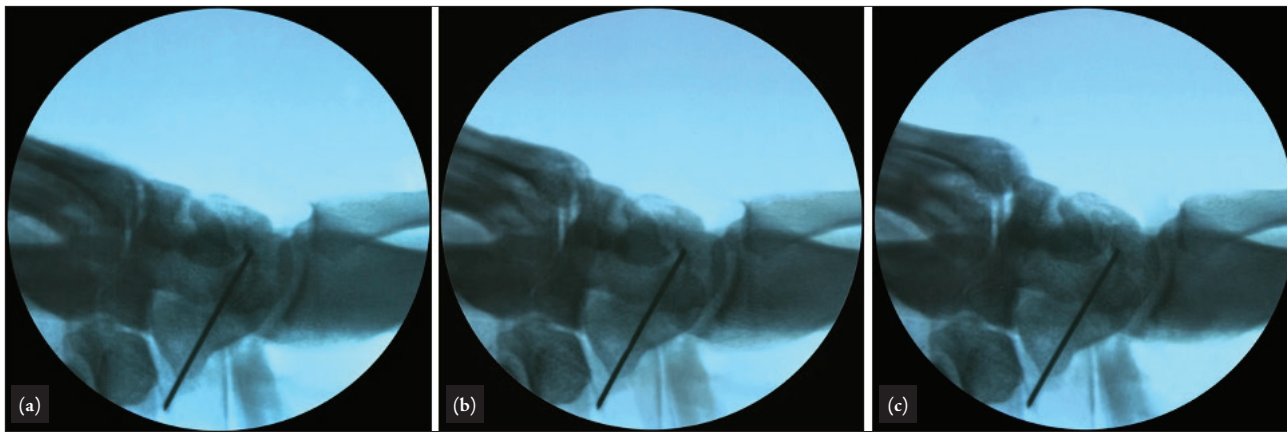


Figure 2. Consecutive fluoroscopic views taken at 45° oblique pronation. **(a)** Fifth metacarpal base in a reduced position. **(b)** Fifth metacarpal base with 25% dislocation. **(c)** Fifth metacarpal base with 50% dislocation (Images were post-processed to remove photographic artifacts (screen reflections and border shadows) without modification of fluoroscopic content, anatomical structures, or joint appearances).

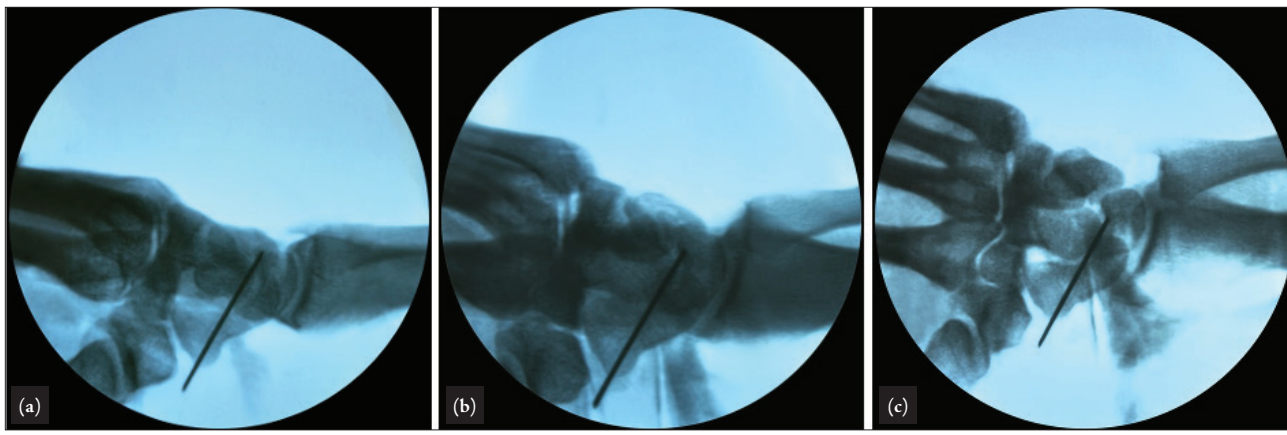


Figure 3. Consecutive fluoroscopic views of the fifth metacarpal base in 50% dislocated position. **(a)** 30° oblique view. **(b)** 45° oblique view. **(c)** 60° oblique view (Images were post-processed to remove photographic artifacts [screen reflections and border shadows] without modification of fluoroscopic content, anatomical structures, or joint appearances).

cal Package for the Social Sciences (SPSS), version 26.0 (IBM Corp., Armonk, NY, USA). In this study, the Chi-Square test was used to compare the diagnostic performance of the evaluator in assessing joint dislocation status at different angle positions (30°, 45°, 60°), and the results were presented as numerical (n) and percentage (%) distributions. The evaluator's diagnostic performance at each angle position was assessed using sensitivity, specificity, positive/negative likelihood ratios (LR+/LR−), positive/negative predictive values (PPV/NPV), and accuracy metrics, with reference to the gold standard. For dependent group comparisons, McNemar's test was applied. The level of statistical significance was set at α=0.05 (two-tailed).

RESULTS

Oblique radiographs taken at a 60° angle demonstrated the highest sensitivity but the lowest specificity for detecting fifth CMC dislocation. Whereas those taken at a 30° angle

Table 1. Sensitivity and specificity of different oblique radiographic views in diagnosing fifth carpometacarpal joint dislocation

Oblique radiographic angles	Sensitivity % (95% CI)	Specificity % (95% CI)
30°	31.05 (25.0–37.6)	92.47 (85.1–96.9)
45°	64.53 (58.0–70.7)	84.27 (75.0–91.1)
60°	65.56 (59.6–71.2)	79.25 (65.9–89.2)

CI: Confidence interval.

showed the lowest sensitivity but the highest specificity (Table 1). The diagnostic accuracy of orthopedic residents was significantly higher than that of orthopedic consultants, at 58.8% and 49.2%, respectively (p=0.002). When uncertain responses were considered incorrect, the percentages of correct diagnoses were 45.3% for 30° oblique radiographs, 59.5% for 45° radiographs, and 60.8% for 60° radiographs (p<0.001). Regarding the degree of dislocation, candidates correctly identified 25% dislocation in 39% of cases, 50% dislocation in 58% of cases, and reduced joints in 78.1% of cases. After excluding uncertain responses, the accuracy of 30°, 45°, and 60° oblique radiographs was 49.36% (43.7–55.1), 69.97% (64.7–74.9), and 67.80% (62.4–72.9), respectively. The LR+/LR− for 30°, 45°, and 60° oblique radiographs were 4.13/0.75, 4.10/0.42, and 3.16/0.46, respectively. PPV/NPVs for 30°, 45°, and 60° oblique radiographs were 90.67/36.29, 91.52/47.47, and 94.15/31.11.

DISCUSSION

Dislocation of the fifth CMC joint can be easily missed at initial presentation due to swelling on the dorsum of the hand, which may obscure visible deformity or make clinical signs, such as a palpable lump, difficult to detect.[20] Furthermore, overlapping of the metacarpal bones on lateral radiographs and of the carpal bones on anteroposterior views can make accurate diagnosis even more challenging, especially for inexperienced surgeons.[19,21] A delayed diagnosis may prevent successful closed reduction, making open surgical reduction necessary to restore joint alignment.[22] Zhang et al.[4] reported six missed diagnoses out of 26 cases. Conservative treatment in these patients led to poor clinical outcomes and eventually resulted in degenerative arthritis. In a study evaluating the impact of radiological re-assessments on forensic reports, misinterpretation of bone fractures was a common source of error, with the upper limb representing the second most frequently affected region. False-negative and false-positive rates for metacarpal fractures were 7.1% and 16.4%, respectively. These inaccuracies may influence not only diagnosis and treatment but also the outcomes of forensic evaluations.[23]

Fisher et al.[15] described a method for detecting fourth and fifth metacarpal dislocations on posteroanterior views by identifying parallel "M lines" and ensuring joint surfaces are aligned with a consistent 1–2 mm space. In addition, fractures at the base of the metacarpals or carpal bones should raise suspicion of a CMC dislocation. Hodgson and Shewring found that metacarpal cascade lines should converge toward a point just proximal to the distal radius articular surface. Deviation from this convergence may help detect even minor dislocations of the fourth and fifth CMC joints.[16] Parkinson and Paton identified a method to diagnose dislocation of the fifth CMC by measuring the angle between the axis of the fifth and the fourth metacarpal bone and found that mean of the normal angle was 9.5° while in dislocated cases, it was 39.5°.[17] However, this method was unreliable for subluxation where the angle was 14°. Henderson and Arafa recommend obtaining a lateral hand radiograph if a posteroanterior view shows loss of joint symmetry, overlap, or metacarpal shortening, or if there is dorsal hand swelling with no clear abnormality on standard views.[10,18]

Cain et al.[8] demonstrated that 45° pronation oblique radiographs can help diagnose injuries to the fourth and fifth CMC joints, while 15° pronation oblique views are useful for assessing damage to the dorsal aspect of the fifth CMC joint. Niechajev evaluated oblique radiographs at 30° and 60° in both pronation and supination positions and found that the 60° supination view was superior, as it allowed the base of the fifth metacarpal to be free from overlap and provided a clear view of the intermetacarpal joint.[2] Stapczynski suggested using a 45° oblique supination view with the fingers extended (Norgaard view) or cupped (Ball-Catcher's view) to improve visualization of the CMC joints.[24] Bora and Didizian described that a clear view of the fifth CMC articular surface can be obtained by pronating the forearm 30° from the routine anteroposterior position.[22] Previous authors based their suggested radiographic views mostly on their experience and common clinical practice. In addition, supination views are helpful in visualizing fractures at the base of the fifth metacarpal but may miss dorsal dislocations. In contrast, pronation views are more effective in detecting dorsal dislocations but may fail to reveal injuries of the fourth and fifth CMC joints. All previous approaches may be practical for experienced orthopedic surgeons; however, it can be difficult for general practitioners and emergency doctors to remember and apply in a busy clinical setting.

Hassan et al.[25] evaluated the diagnostic accuracy of four radiographic views (posteroanterior, lateral, pronated oblique, and supinated oblique) for ring and little finger CMC joint injuries among orthopedic trainees and emergency nurse practitioners. The 15°–20° pronated oblique view from the true lateral demonstrated the highest sensitivity, whereas the supinated oblique showed the lowest. Furthermore, the combination of posteroanterior, true lateral, and pronated oblique views correctly identified 78% of injuries.

A previous cadaveric study by Johnson et al.[19] reported high sensitivity and specificity of 60° pronated radiographs from the lateral compared to 30° and 45°. In our study, we aimed to validate and build upon the existing findings. This is particularly valuable for early and accurate diagnosis, which remains a challenge in clinical settings. Results of this study also showed 60° as the most sensitive angle as previously reported. However, the sensitivity rates were lower than previously reported, which may be due to the limited radiographic quality, as the images were acquired using fluoroscopy and a digital camera. In addition, sensitivity at 45° was comparable to sensitivity at 60° angle unlike previously reported where 30° angle was comparable to 60° angle.

In a study evaluating the diagnostic power of plain radio-

graphs (anteroposterior, lateral, and oblique) for fourth and fifth CMC fracture–dislocations found low sensitivity and only slight interobserver agreement, suggesting that computed tomography (CT) scan should be incorporated into emergency diagnostic protocols for these injuries.[26] Potini et al.[18] described a screening method based on measuring the capitate-metacarpal angle and recommended CT scanning for patients with angles >15°. The findings of the present study, in which the best-performing 60° oblique view demonstrated a sensitivity of only 65.6%, are consistent with this recommendation and further support the use of CT as an adjunct when clinical suspicion persists.

Radiology perception research has shown that diagnostic accuracy for specific radiographic tasks improves with training.[27] It is interesting to note that the average accuracy of the trainees was higher than that of the consultants. Similar results were reported in a study to evaluate the diagnostic accuracy between radiologists and radiology residents to diagnose appendicular fractures.[28] Differences in diagnostic performance may relate to more recent training exposure among residents, reduced reliance on clinical history, and the presence of supervisory safeguards, whereas consultants may depend more on clinical context and independent reporting. In this study, performance was highly task-specific rather than uniformly experience-dependent which suggests that seniority alone does not guarantee superior diagnostic performance for uncommon or subtle findings. In addition, trainees were based in a tertiary trauma center, particularly within a specialized hand trauma unit.

In clinical practice, CMC joint fracture–dislocations occur more often than pure dislocations without fracture, and dorsal dislocations are much more common than volar ones.[15] The present model, which simulated pure dorsal dislocation at standardized degrees, therefore represents a situation that may be less visible on radiographs than typical clinical cases, which often include associated hamate or metacarpal base fractures that provide additional imaging clues. Accordingly, the sensitivity values reported here should be considered cautious estimates; oblique views may perform better in real clinical settings where fracture fragments make the injury easier to detect on radiographs. However, clinicians must carefully evaluate radiographs to avoid missing associated dislocations in regions not directly related to the fracture site.[11]

This study had several limitations. The fifth CMC dislocation was experimentally induced and may not fully represent actual clinical injuries, which often involve fracture-dislocations or bony fragments. However, by focusing on simple dislocations with minimal dislocation, the study may have demonstrated a method that is even more sensitive when applied to more complex injuries. All reviewers were informed that the study concerned fifth CMC dislocations, which may have introduced expectation bias and potentially influenced the accuracy of their assessments.

CONCLUSION

Based on current and previous evidence, initial assessment should include standard posteroanterior, true lateral, and 60° pronation oblique radiographs. If the mechanism involves axial loading and clinical signs such as dorsal swelling and point tenderness over the CMC joint persist despite inconclusive radiographs, CT imaging should be obtained. This stepwise approach balances radiation exposure and resource use while minimizing the risk of missed diagnoses.

Ethics Committee Approval: This study was approved by the Ege University Review Board (Date: 04.09.2025, Decision No: 25-9T/20). The authors declare that the work described has been carried out in accordance with the Declaration of Helsinki of the World Medical Association, revised in 2013, for experiments involving humans.

Peer-review: Externally peer-reviewed.

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Informed Consent: The authors declare that this report does not contain any personal information that could lead to the identification of the patient(s) and/or volunteers.

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DENEYSEL ÇALIŞMA - *ÖZ*

Ulnar taraflı karpometakarpal çıkıkların saptanmasında oblik x-ray projeksiyonlarının değerlendirilmesi: Bir kadavra çalışması

AMAÇ: Ulnar taraflı karpometakarpal (KMK) eklemlerin çıkıkları ve kırık-çıkıkları nadir görülen yaralanmalardır ve genellikle ilk klinik değerlendirmelerde gözden kaçırılır. Bunun başlıca nedeni, radyografik bulguların belirsiz olması ve anatomik yapıların üst üste binmesidir. Kaçırılan veya gecikmiş tanı, kronik instabiliteye, sürekli ağrıya ve suboptimal fonksiyonel sonuçlara yol açabilir. Bu çalışma, kontrollü bir kadavra modelinde beşinci KMK eklem çıkıklarının tanısında farklı oblik radyografik projeksiyonların tanısal duyarlılık ve özgüllüğünü değerlendirmeyi ve karşılaştırmayı amaçlamıştır.
GEREÇ VE YÖNTEM: Bu çalışmada, modifiye Larssen solüsyonu ile korunan Altı insan kadavra eli kullanıldı. Beşinci KMK eklemin doğal hizası, %25 çıkık ve %50 çıkık olmak üzere üç farklı eklem durumunda, lateral görünümden 30°, 45° ve 60° açılarda oblik floroskopik görüntüler alındı. Standartize görüntüleme sabit bir dijital sistemle gerçekleştirildi. Toplam 54 randomize görüntü, 20 ortopedi cerrahı (7 uzman ve 13 kıdemli asistan) tarafından incelenen bir anket haline getirildi. Cerrahlar beşinci KMK ekleminin durumunu "çıkık", "çıkık değil" veya "belirsiz" olarak sınıflandırdı. Her oblik açı için duyarlılık, özgüllük ve genel tanısal doğruluk hesaplandı.
BULGULAR: 60° oblik radyografiler, çıkıkların tespitinde en yüksek duyarlılığı gösterdi ancak özgüllükte orta düzeyde bir azalma oldu. Buna karşılık 30° görünüm en yüksek özgüllüğe sahipken en düşük duyarlılığa sahipti. 45° oblik radyografiler daha dengeli bir tanısal profil sundu. Genel olarak 60° oblik radyografiler en yüksek tanısal doğruluğu sağladı. İlginç bir şekilde, kıdemli asistanlar uzmanlara göre anlamlı derecede daha yüksek tanısal doğruluk gösterdi.
SONUÇ: 60° oblik radyograf, beşinci KMK çıkıklarının tespitinde en iyi performansı göstermesine rağmen, duyarlılığı tek başına tanısal araç olarak kullanılacak düzeyde yeterli değildir. Klinik şüphe radyografilerde belirsizliğe rağmen devam ediyorsa, bilgisayarlı tomografi (BT) taraması önerilir.

Anahtar sözcükler: Çıkık; karpometakarpal eklem; oblik radyografiler.

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