JOURNAL OF
CONTEMPORARY MEDICINE

DOI:10.16899/jcm.1069082
J Contemp Med 2022;12(2):325-331

Orijinal Araştırma / Original Article

Prevalence of Enchondromas of the Hand in Adults as Incidental Findings on Magnetic Resonance Imaging

Erişkinlerde Başka Sebeplerden Ötürü Çekilen Manyetik Rezonans Görüntülemede Saptanan El Enkondromlarının Prevalansı

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Abstract

Purpose: To determine the prevalence of enchondromas (EC) in adults as incidental findings in the long bones of the upper extremities and the bones of the hand on magnetic resonance imaging (MRI).

Material and Method: A retrospective review of upper extremity MRI scans for the presence of incidental EC in patients older than 18 years was performed. EC location, size, and appearance were defined. Age, gender, MRI region, side, most common symptom, eccentric or central location in the bone, affected finger, presence of biopsy, presence of trauma history,and size of enchondroma were evaluated.

Results: A total of 9713 upper extremity MRIs were evaluated. In our study, the prevalence of EC in the entire upper extremity was 1.2% with MRIs that performed for upper extremity bones only. EC was most commonly seen in MR imaging of the hand. The proximal phalanx was the most commonly affected bone. Often presentin the third and fourth decades of life and the ulnar side of long bones were affected. In our study, the overall prevalence of hand EC was 4.8%. While the incidence of hand enchondromas was 5.8% in females, it was 4.1% in males. The incidence of enchondromas in the hand was approximately 5.77 times higher than in the shoulder.

Conclusion: This study suggests that with the prevalence of EC, as determined by MR imaging, the hand should continue to be considered the most common site for enchondromas.

Keywords: Prevalence of enchondromas, hand, incidental findings, upper extremities, magnetic resonance imaging

Öz

Amaç: Manyetik rezonans görüntülemede (MRG) üst ekstremite uzun kemikleri ve el kemiklerinde tesadüfi bulgular olarak erişkinlerde enkondrom (EK) prevalansını belirlemek.

Gereç ve Yöntem: 18 yaşından büyük hastalarda tesadüfi EC varlığı için üst ekstremite MRG taramalarının retrospektif bir incelemesi yapıldı. EC konumu, boyutu ve görünümü tanımlandı. Yaş, cinsiyet, MRG bölgesi, taraf, en sık görülen semptom, kemikte eksantrik veya santral yerleşim, etkilenen parmak, biyopsi varlığı, travma öyküsü varlığı ve enkondrom boyutu değerlendirildi.

Bulgular: Toplam 9713 üst ekstremite MRG'si değerlendirildi. Çalışmamızda sadece üst ekstremite kemikleri için yapılan MRG'lerde tüm üst ekstremitede EC prevalansı %1.2 idi. EC en sık elin MR görüntülemesinde görüldü. Proksimal falanks en sık etkilenen kemikti. Genellikle yaşamın üçüncü ve dördüncü dekatlarında ortaya çıkar ve uzun kemiklerin ulnar tarafı etkilenir. Çalışmamızda el EC'nin genel prevalansı %4.8 idi. El enkondromlarının insidansı kadınlarda %5,8 iken erkeklerde %4,1 idi. Eldeki enkondrom insidansı omuzdakinden yaklaşık 5.77 kat daha fazlaydı.

Sonuç: Bu çalışma, MR görüntüleme ile belirlenen EC prevalansı ile birlikte, elin enkondromlar için en yaygın bölge olarak düşünülmeye devam etmesi gerektiğini düşündürmektedir.

Anahtar Kelimeler: Enkondrom prevelansı, el, kısa tubuler kemik, üst ekstremite, MR

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Received *(Geliş Tarihi)*: 06.02.2022 **Accepted *(Kabul Tarihi)*:** 16.02.2022

INTRODUCTION

Enchondromas (EC) are generally solitary, inactive, and asymptomatic benign cartilage neoplasms occurring in the bone marrow.[1] According to classic information based on radiographs, EC occurs most frequently in the hand.[2,3] The World Health Organisation's classification of soft tissue and bone tumors indicates a high prevalence for enchondromas.[4] This classic information is based on simple radiologic data. Advanced imaging techniques such as magnetic resonance imaging (MRI) to identify other pathologies for different skeletal regions do not account for incidentally detected enchondromas. EC can often be found incidentally on MRI scans for various pathologies.[5] One of the most important problems of our time is the incidental discovery of EC on MRI performed at the time of diagnosis of any pathology.[1,2,6] As MRI becomes more common in these studies, knowledge of the prevalence of incidental EC in these studies will contribute to the literature.[1,6,7] In EC prevalence calculation, the fact that MRI scans for another pathology are very easy and cost-effective makes it necessary to re-evaluate these prevalence values.

Detection of EC on radiographs is generally based on destruction of bone[3] or the presence of intralesional cartilage calcifications. Because EC is clinically asymptomatic and does not cause massive bone destruction, most EC are difficult to detect on direct radiographs. Recent publications in the literature answering the question of whether the long bones of the hand are indeed the most common site for EC[3] conclude that the hand should no longer be considered the most common body part for EC. It is thought that this is because radiographs are relatively insensitive compared with MRI in detecting small lesions in larger bones such as the proximal humerus and around the knee.

Our hypothesis is that despite the results of recent MRI studies in the literature, the hand remains the most common site for EC even when high-resolution imaging is used. The purpose of this study is to investigate whether the hand is the most common site for EC among upper extremity enchondromas incidentally detected on upper extremity MRI imaging, which is a more sensitive imaging modality that can show small enchondromas, and the prevalence of EC in the upper extremity.

MATERIAL AND METHOD

We retrospectively analyzed 9713 upper extremity MRI scans performed consecutively for any reason between 2011 and 2020 for the presence of enchondromas (**Figure 1**). Approval was obtained from the local ethics committee of the Faculty of Medicine at …….University. The study was conducted in accordance with the Declaration of Helsinki. The exclusion criteria for the study were patients whose image quality was insufficient to assess the presence of enchondromas, patients younger than 18 years of age, and patients with orthopedic implants at the MRI application area.

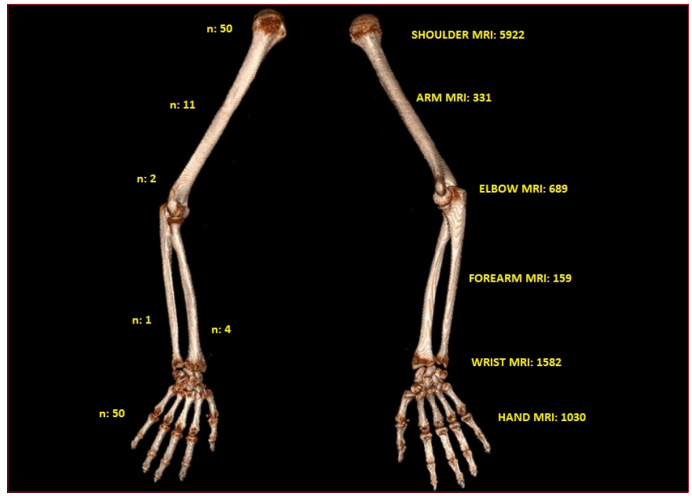

Figure 1. Upper Arm distribution of all MR evaluated and all detected enchondromas.

Low and medium signals in T1 on MRI, chondroid matrix, calcification foci with low signal intensity; cartilage matrix and septal appearance with high signal intensity and low signal intensity in T2, calcification foci with low signal intensity were evaluated in favor of enchondroma. Cases with subchondral lesions, subchondral cysts, intraosseous ganglia, or subchondral edema were not included in the study.

All lesions that met the criteria for a cartilage tumor and were agreed upon by two orthopaedic and traumatology physicians with more than 10 years of experience to determine lesion characteristics were included in the study(OB , ECZ).

MR images from these cases were analyzed using the Image Archiving and Communication System (PACS Sectra Workstation Ids7, Version 21.2.11.6289; ©2019 Sectra Ab). The length and width of all ECdetected in the PACS system were measured. Age, sex, and the bone region in which EC were detected were recorded. For subsequently discovered hand EC, an additional examination was performed using the ENLIL system(ENLIL hospital information management system, version v2.19.46 20191118). Symptoms of EC in the hand at the time of admission, whether there was previous trauma, whether a biopsy was performed, whether surgery was required, on which side they occurred, which bone and finger were affected, and whether they were centrally or eccentrically located were recorded.

All MRI examinations were performed on a 1.5 scanner (1.5T and 3T Siemens, Erlangen, Germany) at a single facility.

Statistics

Data obtained were analyzed using IBM SPSS Statistics software (software version 23.0). Main data were analyzed using the Kolmogorov-Smirnov test. However, a smaller group of patients with hand chondromas was analyzed with the Shapiro-Wilk test. Descriptive statistics were presented as mean ± SD and categorical values. The Student T test and

Mann-Whitney U test were used to compare data between groups. The chi-square test, Fisher exact test, and Fisher-Freeman-Halton test were used to evaluate the categorical variables. A p value of <0.05 was considered statistically significant for all tests.

RESULTS

In our study, EC were detected in 71 female and 47 male patients. The prevalence of EC in the upper extremity in females was 1.19%. The prevalence of upper extremity enchondromas in men was 1.27%. The most common age range was 41-50 years (24.7%) (**Table 1**).

Table 1. Descriptive statistics of individuals with enchondromas

	Count	%
Gender		
Female	71	60.2
Male	47	39.8
Extremity MR area		
Hand	44	10.6
Wrist	7	16.3
Forearm	4	1.6
Elbow	2	7.1
Upper Arm	11	3.4
Shoulder	50	61
Location of Enchondroma		
Proximal Phalanx	22	18.6
Metacarpal	18	15.3
Middle Phalanx	10	8.5
Distal Ulna	1	0.8
Distal Radius	4	3.4
Humerus Proximal Metaphysis-Diaphysis	10	8.5
Humerus Anatomical Neck	8	6.8
Head of Humerus	13	11.2
Humerus Surgical Neck	15	12.7
Tuberculum Majus	3	2.5
Humerus Distal Metaphysis-Diaphysis	1	0.8
Humerus Distal Metaphysis	2	1.6
Humerus Proximal 1/3 Diaphysis	6	5.1
Humerus Shaft	5	4.2
Zone of the Enchondroma		
Hand	50	42.4
Radius	4	3.4
Ulna	1	0.8
Distal Humerus	2	1.6
Humerus Shaft	11	3.4
Proximal Humerus	50	42.4
Age Groups		
11-20	3	2.5
21-30	18	15.3
31-40	20	16.9
41-50	29	24.7
51-60	15	12.7
61-70	28	23.7
71-80	5	4.2

MRI was performed mostly on the shoulder in both women and men (**Figure 2**). In our study, the prevalence of enchondroma was found to be 1.2% in the entire upper extremite (**Figure 2**).

The mean both length and width of the tumor were highest in enchondromas detected in the humeral diaphysis (**Figure 3**).

The median age of patients with enchondroma was 44 (**Table 2**). The mean tumor length was 26.7 (range 2-85) mm, and its width was 12.0 mm (range 2-25) (**Table 2**).

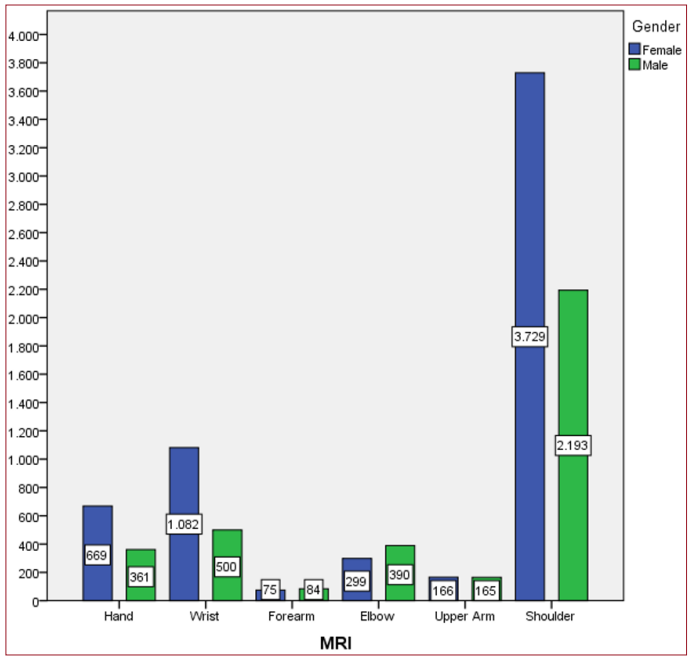

Figure 2. Distribution of all evaluated MRs by gender.

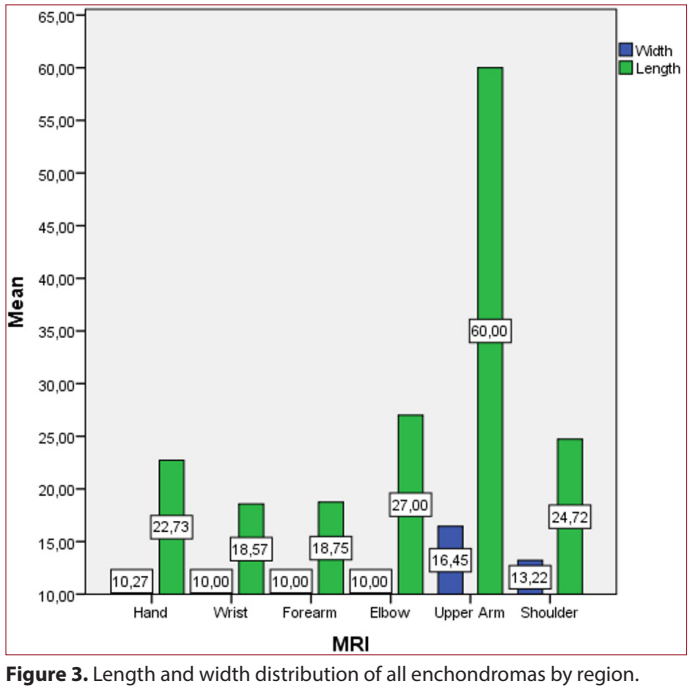

Figure 3. Length and width distribution of all enchondromas by region.

Table 2. Age of the patients and size of the all EC.

	N	Mean	Median	SD	Min	Max	IQR
Age	118	46.7	44	15.3	18	78	35-61
Length	118	26.7	20	19.2	2	85	15-32
With	118	12	10	5.2	2	25	8-16

A total of 50 patients were found to have EC on hand MRI. Of these EC, 22 were located in the proximal phalanx, 18 in the metacarpal, and ten in the middle phalanx. Most EC were located in the hand bones on the ulnar side. EC were found in the radius in four patients and in the ulna in one patient (**Figure 4**). None of the patients had Ollier disease or Maffucci syndrome.

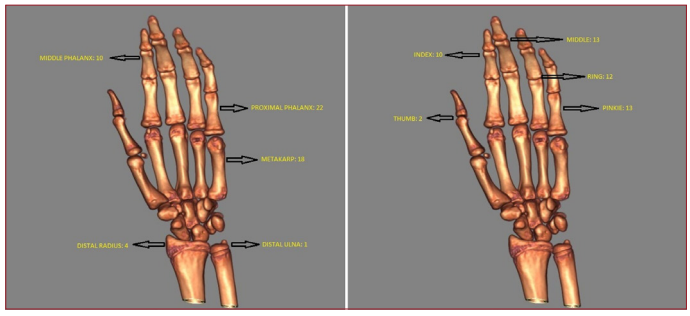

Figure 4. Hand distribution of enchondromas

None of the lesions had evidence of an endosteal scalloping, associated soft tissue mass, or surrounding bone marrow edema suggestive of chondrosarcoma. The overall incidence of hand EC was 4.85% in all hand MRI. While the incidence of hand EC was 5.8% in women, it was 4.15% in men. Hand EC occurred most frequently in the age group 31-40 years (6.46%), followed by the age group 18-30 years (6.28%).

EC was found in the proximal humerus in 50 patients, in the humeral shaft in 11 patients, and in the distal humerus in two patients (**Figure 5**). The incidence of enchondroma on MRI of the shoulder was 0.84%. The likelihood of enchondroma in the hand was approximately 5.77 times higher than in the shoulder. While the probability of enchondroma in the shoulder was 0.75% in women, this rate was 1% in men. The highest incidence of shoulder enchondromas was between 61 and 70 years of age (1.19%), followed by the age groups 41-50 (1.07%) and 31-40 years (0.84%).

Six patients with hand chondromas whose records could not be fully retrieved through our hospital's ENLIL system were excluded from the study. Twenty-eight (63.6%) of the 44 hand enchondroma patients whose hand MRIs could be evaluated in detail and clinical examination could be achieved were female (**Table 3**). The dermographic data of the hand EC patients whose clinical data were fully accessible are shown in **Table 1**.

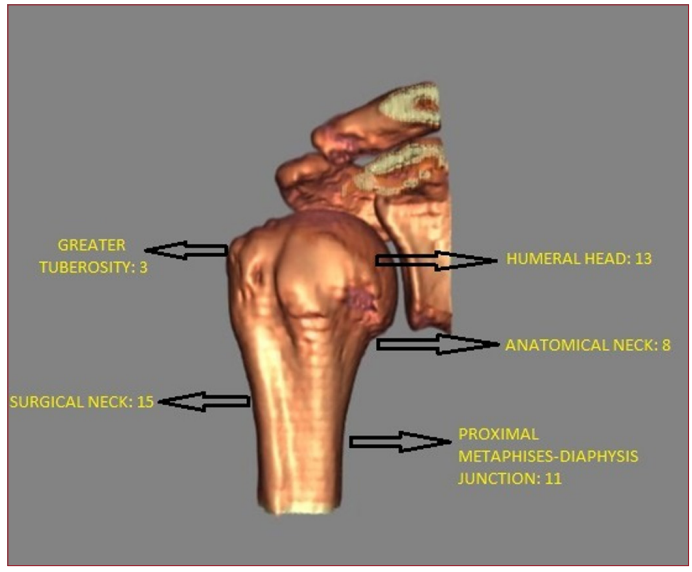

Figure 5. Distribution of enchondromas in the proximal humerus.

Table 3. Comparison of hand EC between genders.

	Female (n=28)	Male (n=16)	p
Side			0.864
Right	13	7	
Left	15	9	
Most Common Symptom			0.668**
Swelling	14	10	
Pain	11	4	
Pathological Fracture	3	2	
Location in bone			0.039
Eccentric	12	12	
Central	16	4	
Bone of hand			0.560**
Proximal Phalanx	11	9	
Metacarpal	11	4	
Middle Phalanx	6	3	
Finger			0.470**
Thump	2	0	
Index	6	4	
Middle	6	7	
Ring	8	2	
Pinky	6	3	
Biopsy			0.227
Present	14	5	
Absent	14	11	
Trauma			>0.999*
Present	3	2	
Absent	25	14	
Operation			0.314*
Present	10	3	
Absent	18	13	

Chi-square test was performed. * Fisher's Exact test was performed**Fisher-Freeman-Halton test was performed.

The hand EC is more eccentrically located in the male sex. The most common complaint of patients with hand chondromas (54.5%) was swelling, followed by pain (34.1). 11.4% of patients had pathologic fractures. On radiographic examination, the tumor was eccentrically located in 54.5%. Enchondromas in the hand were most common in the proximal phalanx (45.5%), followed by the metacarpal (34.1%). The third finger was most commonly affected (29.51%) and the first finger was least commonly affected (4.6%). 11.4% of patients had a history of trauma. The comparison of quantitative data are shown in **Table 4**. The mean age of the 44 patients was 40 SD14.4 years. The median age was 39 years. The length was 22.7 SD8.2 mm, and the width averaged 10.2 SD3.8 mm. Although length and width were greater in men, they were not statistically significant.

Table 4. Comparisonof variables for hand EC between genders

	Female (n=28)	Male (n=16)	p
Age	42.2±14.5	37±14.0	0.247
Lenght (mm)	22.6±8.1	22.8±8.7	0.959
Width (mm)	9.9±3.6	10.8±4.2	0.311

DISCUSSION

Although most cartilage tumors are clinically inconspicuous, studies of their epidemiology are mostly based on classic radiologic evaluations. One of the most important problems is the incidental detection of EC on magnetic resonance imaging (MRI), which is observed on MRI of the extremities and performed in the diagnosis of other joint pathologies.[6,8-10] It is a problem that is increasing in importance day by day and may lead to different conclusions about its prevalence. Therefore, it is important to know the true prevalence of enchondromas in MRI examinations of the extremities.

To our knowledge, our study is the first to determine the incidental prevalence of EC in MRI of all upper extremity bones. When we look at the literature, it is seen that the studies conducted on the evaluation of incidental prevalence are insufficient. The study of EC of the hand that we found in the literature was performed by Davies et al.[3] Based on the MRI study and the fact that MRI is more sensitive than radiographs in identifying EC, Davies et al.[3] found in this study that EC in the hand are relatively rare in contrast to classic findings. Davies et al.[3] In their study, they found that the incidence of EC in the hand should be 5% in trauma series, as the incidence in the proximal humerus and knee is approximately 2.5% in routine MRI examinations.[3] However, in their study, they found a lower rate. In our study, a total of 9713 MRIs of the upper extremities were examined. In MRI examinations that included all upper extremity bones, our study found a prevalence of 1.2% for enchondromas in the entire upper extremity. The EC was mostly seen in the MR imaging of the hand region. The prevalence of upper extremity EC in women was 1.19%. The prevalence of upper extremity EC in men was 1.27%. Hong et al. His studies have shown that EC is a relatively common incidental finding in the proximal humerus (2.1%)(6). In our study, the incidence of EC on MRI of the shoulder was 0.84%. The incidence of EC in the hand was approximately 5.77 times higher than in the shoulder. In our study, the incidence of shoulder enchondromas in women was 0.75%, whereas this rate was 1% in men. The results of our study corresponds with studies that performed with classic radiography rather than the results of MRI-based studies that Davies et al. conducted.

In a retrospective study by Simon et al.[11] EC was the most common tumor on the hand (47.1%). In our study, we included only cases in which EC was found in the hands and upper extremities. In our study, the overall incidence of hand EC was 4.85%. While the incidence of hand EC in women was 5.8%, it was 4.15% in men. Gaulke at al investigated 327 solitary EC of the hand in their study, and the incidence of proximal phalanx and little finger involvement was quite high. In our MRI-based study, enchondromas were detected in a total of 50 patients. Of these enchondromas, 22 were located in the proximal phalanx, 18 in the metacarpal, and ten in the middle phalanx. Gaulke et al.[12] reported that the proximal phalanx of the little finger was the most commonly affected bone.[12] The proximal phalanges (48.9%) and little fingers (34.3%) were the most commonly affected. In our MRI-based study, the EC were mostly located in the hand bones on the ulnar side. In the study by Gaulke et al.[12] these lesions often develop in the third and fourth decades of life and prefer long bones with ulnar borders. In our study, hand EC occurred most frequently in the age group of 31-40 years (6.46%), followed by the age group of 18-30 years (6.28%).

Most EC are asymptomatic and are not discovered until they show symptoms such as swelling, pain, and deformity. Tang et al.[13] noted that EC were discovered as incidental findings on radiographs without obvious symptoms or pain. Bauer et al.[14] noted a low risk of pathologic fractures in their study. In contrast, in the series reported by Sassoon et al.[15] 102 patients with hand EC had a pathologic fracture rate of 40% (n=41). In our study, the most common complaint of patients with hand EC (54.5%) was swelling, followed by pain (34.1%) and 11.4% of patients had pathologic fractures.

In studies of EC, incidental EC were found in 0.8% to 2.9% of routine examinations with a wide range of different results.[8-10] After examination of shoulder pain with plain radiographs, computed tomography (CT), and magnetic resonance imaging (MRI), incidental chondral tumor findings are estimated to be 2% to 4%.[16] The higher detection rates in MRI studies likely reflect the higher sensitivity of MRI to detect small lesions. Davies et al.[17] the prevalence of incidentalEC from the proximal femur on MRI is 0.7%. In their study determining the stromal prevalence of cartilage tumors as incidental findings on MRI of the

knee, they found a 2.8% prevalence of EC.[9] In an autopsy case series, a prevalence of EC of only 0.2% was observed.[18] The reported prevalence for MRI examinations of the knee performed because of pain ranged from 2.3% to 2.9% (8-10). In 601 healthy subjects, the prevalence of knee was only 0.8%.[8] Incidentally, cartilage tumors detected in the knee were most commonly found in the distal femur (approximately 2%), followed by the proximal tibia (0.5-0.7%) and proximal fibula (0.1-0.2%), and were generally small.[9,10] Hong et al.[6] reported that the prevalence of cartilage tumors found incidentally on MRI of the shoulder was 2.1%. Walden et al.[10] reported a 2.9% prevalence of EECs on clinical knee MRI. The prevalence of enchondromas in skeletally immature children undergoing knee MRI for various reasons was also 2.9%.[19]

Stomp et al.[9] reported that among the 1285 MRI examinations of the knee, 86% of 49 tumors were smaller than 2 cm. In Walden's study, which included 449 knee MRI examinations, 57% of 23 tumors were smaller than 1 cm.[10] In the shoulder extension study (which included 477 MRI examinations), seven of the ten incidentally detected ECs were smaller than 1 cm, and the three larger ones measured 1.2 cm or less.[6] In our study, the mean tumor length was 26.7 (range 2-85) mm and width was 12.0 mm (range 2-25).

An important limitation of our study is its retrospective nature. Although most MR scans are performed with 1.5 T protocols, the protocols are not uniform. In addition, not all EC diagnosed in this study underwent pathologic confirmation. However, we believe that the criteria established for the diagnosis of an EC are sensitive enough. Subchondral lesions and subchondral cysts were excluded in this study. Therefore, we believe that the prevalence of enchondromas was correctly reported in this article.

Accordingly, EC of the hand most commonly affects the proximal phalanx. The characteristic clinical findings and the easily recognizable findings on imaging studies make this diagnosis straightforward. Radiographically, enchondromas appear as well-demarcated, expansive, lytic lesions with varying degrees of striated or punctate, annular and arctal calcification. However, annular and arctic calcification is not seen in all cases.[20] Calcification foci on MRI have low signal intensity in all sequences. Low to moderate signal intensity on T1-weighted images shows signal intensity of a cartilage tumor and inhomogeneous high signal intensity with septa with low signal intensity onT2-weighted images shows signal intensity of a cartilage tumor. MRI is better for the evaluation of bone marrow and soft tissue edema.[21]

CONCLUSION

Enchondromas of the hand are still most common, although radiographs have become relatively insensitive in detecting small lesions in larger bones such as the proximal humerus and around the knee compared with MRI.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was initiated with the approval of the Gaziosmanpaşa Universty Hospital Ethics Committee (Protocol No: 21-KAEK-235).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Note: This manuscript was presented as an oral presentation in 'International Intensive Care Symposium 2021'

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