ORIGINAL ARTICLE

IMAGING PREDICTORS OF CONTRACTURE IN DUPUYTREN'S DISEASE: MULTIMODAL ULTRASONOGRAPHIC PERSPECTIVE

Dupuytren Hastalığında Kontraktür Gelişiminin Görüntüleme Yöntemleriyle Öngörülmesi: Multimodal Ultrasonografik Değerlendirme

Erdem OZKAN[1], Mehtap BALABAN[2], Elif Banu GULER[3], Atilla Hikmet CILENGIR[4]

[1]Kastamonu Eğitim ve Araştırma Hastanesi, Radyoloji Bölümü, Kastamonu, Türkiye.
[2]Yıldırım Beyazıt Üniversitesi, Radyoloji Anabilim Dalı, Ankara, Türkiye.
[3]Ankara Bilkent Şehir Hastanesi, Radyoloji Bölümü, Ankara, Türkiye.
[4]İzmir Demokrasi Üniversitesi, Radyoloji Bölümü, İzmir, Türkiye.

Erdem ÖZKAN, Dr.
(0000-0001-8120-7051)
erdemozkan5454@gmail.com
Mehtap BALABAN,
(0000-0002-6752-6838)
mehtapbalaban@aybu.edu.tr
Elif Banu GÜLER,
(0009-0001-2568-2533)
elifbanuguler@gmail.com
Atilla Hikmet ÇİLENGİR,
(0000-0002-4073-9665)
acilengir@gmail.com

İletişim:
Dr. Erdem ÖZKAN
Kastamonu Eğitim ve Araştırma Hastanesi, Radyoloji Bölümü, Kuzeykent 57. Alay Caddesi, Cankat Sok, No:4, 37150 Merkez/Kastamonu

Geliş tarihi/Received: 07.08.2025
Kabul tarihi/Accepted: 03.11.2025
DOI: 10.16919/bozoktip.1759985

Bozok Tıp Derg 2025;15(4):420-429
Bozok Med J 2025;15(4):420-429

ABSTRACT

Objective: To investigate ultrasonographic (US), color Doppler ultrasonographic (CDUS), and strain elastography (SEL) characteristics of Dupuytren's disease (DD) and assess their relationship with clinical findings and lesion morphology.

Material and Methods: A total of 226 patients (153 males, 73 females; mean age: 61.5 ± 9.9 years) and 226 lesions were retrospectively analyzed. Lesions were evaluated using B-mode US, CDUS, and SEL for echogenicity, morphology, dimensions, vascularity, stiffness, and anatomical relationships. Flexion deformity and extension of flexor tendons and/or muscular structures were recorded. Statistical comparisons were performed using chi-square, Mann-Whitney U, and Spearman correlation tests.

Results: Lesions were most frequently located in the 4th (74.3%) and 5th (23.9%) finger. Cord-like morphology was observed in 62.8%, and 83.6% were hypoechoic. Flexion deformity was detected in 42.9% of cases and was significantly more frequent in lesions with tendon and/or muscular extension (81.3% vs. 0%; $p < 0.001$). The deformity was also more common in cord-like than nodular lesions (66.2% vs. 3.6%, $p < 0.001$). Iso-hyperechoic lesions were more likely to be associated with deformity compared to hypoechoic ones (59.5% vs. 39.7%, $p = 0.026$). In SEL, 52.7% of lesions were stiff, 41.2% moderate, and 6.2% soft. Lesions with deformity had significantly greater anterior-posterior (AP) diameter ($p = 0.001$). A moderate correlation existed between transverse and AP size ($\rho = 0.631$, $p < 0.001$).

Conclusion: Flexion deformity in DD is strongly associated with tendon/muscular extension and lesion morphology. US and SEL parameters offer significant value in clinical evaluation, enabling early identification of severe disease and aiding therapeutic planning.

Keywords: *Dupuytren Contracture; Ultrasound; Elastography; Flexion Deformity*

ÖZET

Amaç: Bu çalışmada Dupuytren hastalığında ultrasonografi (US), renkli Doppler US (RDUS) ve strain elastografi (SEL) bulgularının değerlendirilmesi ve bu bulguların klinik bulgular ve lezyon morfolojisiyle ilişkilerinin araştırılması amaçlandı.

Gereç ve Yöntemler: Toplam 226 hasta (153 erkek, 73 kadın; ortalama yaş: 61,5 ± 9,9 yıl) ve 226 lezyon retrospektif olarak analiz edildi. Lezyonlar, B-mod US, RDUS ve SEL ile ekojenite, morfoloji, boyutlar, vaskülarite, sertlik ve anatomik komşuluk açısından değerlendirildi. Fleksiyon deformitesi ve fleksör tendon ve/veya musküler yapılara uzanım kaydedildi. Karşılaştırmalarda ki-kare testi, Mann-Whitney U testi ve Spearman korelasyon analizi kullanıldı.

Bulgular: Lezyonlar en sık 4. (%74,3) ve 5. (%23,9) parmaklar düzeyinde lokalizeydi. Morfolojik olarak lezyonların %62,8'i kord şeklindeydi ve %83,6'sı hipoekoikti. Fleksiyon deformitesi vakaların %42,9'unda saptandı ve tendon ve/veya musküler yapılara uzanımı olan lezyonlarda belirgin olarak daha sık görüldü (%81,3 vs. %0; $p < 0,001$). Ayrıca, deformite kord morfolojisine sahip lezyonlarda (%66,2) nodüler olanlara (%3,6) kıyasla daha yaygındı ($p < 0,001$). İzo-hiperekoik lezyonlarda deformite görülme oranı hipoekoik lezyonlara göre anlamlı derecede fazlaydı (%59,5 vs. %39,7; $p = 0,026$). SEL ile yapılan değerlendirmede lezyonların %52,7'si sert, %41,2'si orta sertlikte, %6,2'si yumuşak olarak sınıflandırıldı. Deformitesi olan lezyonların anterior-posterior (AP) çapları daha genişti ($p = 0,001$). Transvers ve AP çaplar arasında orta düzeyde korelasyon saptandı ($\rho = 0,631$, $p < 0,001$).

Sonuç: Dupuytren hastalığında fleksiyon deformitesi, özellikle tendon veya nörovasküler yapılara uzanımı olan ve kord morfolojisine sahip lezyonlarla yakından ilişkilidir. Ultrasonografi ve elastografi bulguları, hastalığın ciddiyetini öngörmede ve tedavi planlamasında değerli bilgiler sunabilir.

Anahtar Kelimeler: *Dupuytren Kontraktürü; Ultrasonografi; Elastografi; Fleksiyon Deformitesi*

INTRODUCTION

Dupuytren's disease (DD) is a long-standing fibroproliferative disorder of the hand, marked by a gradual thickening and contraction of the palmar fascia, eventually leading to permanent flexion deformities, most often affecting the fourth and fifth digits (1). Dupuytren's disease is considered the most common type of superficial fibromatosis, with an estimated prevalence of 1–2% in the general population, increasing significantly with age (2). It predominantly affects men and often presents bilaterally (2). Previous research suggests that DD has a multifactorial etiology, involving both genetic predispositions and environmental influences (3). Well-known risk factors for DD are older age, male sex, and a family history of the condition (4). In addition, several comorbidities such as diabetes mellitus, epilepsy, liver diseases, hyperlipidemia, and adhesive capsulitis have also been associated with an elevated risk of developing DD. Lifestyle elements like smoking, heavy alcohol use, and repetitive manual labor have likewise been linked to a higher susceptibility to DD (5). It is believed that the pathogenesis of DD is mediated by fibrogenic cytokines, including TGF-β, FGF, and the Wnt signaling pathway (a key regulator of cell proliferation, differentiation, and fibrogenesis), all of which can be triggered by diverse biological stimuli (6).

While commonly known as palmar fibromatosis, the designation 'Dupuytren's contracture' is generally used when flexion deformities of the fingers are clinically present (7). Clinically, the disease is characterized by firm, non-tender nodules located beneath the palmar skin, which gradually progress and may cause retraction of the tendons, eventually leading to flexion deformities of the fourth and fifth fingers (8). Despite characteristic lesion localization and clinical findings pointing toward DD, imaging is essential to rule out differential diagnoses such as tenosynovitis, trigger finger, ganglion cysts, and other soft tissue pathologies. In addition, imaging techniques allow for accurate assessment of lesion size and its anatomical relationship with adjacent tendons and muscular structures (9). B-mode ultrasonography (US) is the principal and most commonly utilized imaging technique for assessing superficial soft tissue lesions. It facilitates distinguishing solid structures from cystic components within a lesion. Color Doppler US (CDUS) is useful for evaluating the vascular supply within the lesion. Sonoelastography (SEL) is a modern technique that provides additional diagnostic value when assessing tendons, ligaments, muscles, and superficial soft tissue lesions in the musculoskeletal system (10). SEL is broadly categorized into two types: shear wave and strain elastography. Shear wave elastography provides quantitative data on tissue stiffness in kilopascals, whereas strain elastography uses color mapping to qualitatively represent tissue hardness as soft or stiff. Strain (compression) elastography is more practical and user-friendly for evaluating superficial lesions like those observed in DD.

At present, no curative treatment exists for DD. Conservative management strategies, such as modifying daily activities, applying topical agents, or administering corticosteroid injections, can be used in certain patients to reduce symptoms or delay disease progression (11). Flexion contractures may be improved using methods like percutaneous needle fasciotomy, collagenase derived from Clostridium histolyticum, or limited fasciectomy, yet these interventions are not curative. The recurrence rate after surgical intervention ranges from 21% to 85% within five years, depending on the treatment modality and how recurrence is defined (12). In light of these factors, treatment plans should be tailored according to individual patient characteristics. Within this framework, imaging (especially ultrasonography) serves a key function in informing therapeutic choices and guiding procedural strategy. Furthermore, ultrasonography supports the application of minimally invasive techniques like intralesional injections and aids in efficient post-treatment follow-up (9).

Although ultrasonographic findings of Dupuytren's disease have been described previously, studies directly correlating these imaging parameters with flexion deformity severity remain limited. This study aims to fill this gap by providing a systematic multimodal ultrasonographic assessment.

MATERIAL AND METHODS

This retrospective descriptive study was approved by the Clinical Research Ethics Committee of our institution (Decision No: E2-23-5833, dated December 6, 2023)

before commencement. We retrospectively reviewed ultrasonographic reports and corresponding sonographic image sequences of patients preliminarily diagnosed with DD between May 2020 and October 2023. A radiologist with 14 years of experience in musculoskeletal US re-evaluated all examinations. Cases with unilateral involvement were included, and in patients with multiple lesions, the most prominent lesion was selected for analysis. Clinical and physical examination data were also evaluated. Exclusion criteria included a history of rheumatologic disease, malignancy, prior hand surgery, or trauma to the hand. All ultrasound evaluations were conducted with the patient seated and the examined hand placed in a supinated position resting on the anterior surface of the thigh. Lesion size was recorded in both transverse and longitudinal planes. Each lesion was assessed using B-mode US, CDUS imaging, and strain SEL, all performed independently by the same radiologist. All evaluations were carried out using a high-frequency linear probe (5–11 MHz) with the GE Logiq S7 Expert system (GE Healthcare, Milwaukee, WI, USA). Color Doppler ultrasonography was employed to evaluate vascularity within each lesion. Strain SEL was carried out simultaneously, utilizing the same transducer and identical patient positioning as in the B-mode and Doppler evaluations. Tissue elasticity was assessed by applying light manual compression and decompression with the transducer, relying on real-time elastographic color maps superimposed on B-mode images. In elastographic mapping, soft areas appeared red, moderately stiff tissues were displayed in yellow, and firm regions were depicted in green or blue.

We assessed whether DD-related nodules or cords were present, recorded their affected digit localization, measured their size and echogenicity, and noted their extension to flexor tendons (flexor digitorum superficialis and profundus). Additional evaluations included intralesional vascularity on CDUS and tissue elasticity on strain elastography. In the color-coded elastograms, red indicated soft tissue, green represented intermediate stiffness, and blue denoted firm consistency. Lesion size was measured in both transverse and longitudinal axes using B-mode US. Lesion echogenicity was evaluated in comparison to the adjacent tendon and classified as hypoechoic, isoechoic, or hyperechoic.

All statistical analyses were carried out using IBM SPSS Statistics software (Version 22.0; Armonk, NY, USA), applying a 95% confidence interval. The distribution of numerical variables was assessed for normality using the Shapiro–Wilk test. As the data did not follow a normal distribution, comparisons were performed using the chi-square test or Mann–Whitney U test. Anatomical variation differences were specifically analyzed using the Mann–Whitney U test. A p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 226 patients were enrolled in the study, including 153 males (67.7%) and 73 females (32.3%). The mean age of the study population was 61.46 ± 9.9 years, ranging from 23 to 81 years. Female patients had a slightly greater mean age (62.12 ± 10.96 years) than male patients (61.15 ± 9.40 years).

The right hand was affected in 59.3% of cases (n=134), whereas the left hand was involved in 40.7% (n=92). Right-hand lesions were more frequently observed in female patients (71.2%) than in male patients (53.6%). Analysis of etiological factors associated with DD revealed diabetes mellitus as the most frequently encountered comorbidity (34.1%, n=77), followed by tobacco use (17.7%, n=40). Epilepsy and alcohol consumption were identified as rare etiological factors. The majority of lesions (83.6%, n=189) demonstrated hypoechoic characteristics on B-mode US. Morphological assessment revealed that 62.8% of lesions (n=142) exhibited a cord-like configuration, while 37.2% (n=84) presented with nodular morphology.

Color Doppler ultrasonography evaluation demonstrated vascularity in only 3 lesions (1.3%) (Figure 1). Sonoelastographic (SEL) assessment revealed that 52.7% of lesions (n=119) were characterized as stiff, 41.2% (n=93) as moderately stiff, and 6.2% (n=14) as soft (Figure 2). Comparative analysis between genders revealed that males had significantly larger anterior-posterior (AP) dimensions compared to females (p=0.043), while no significant difference was observed in transverse dimensions (p=0.229).

Mean lesion dimensions were 10.99±6.05 mm in the transverse plane and 4.80±2.91 mm in the AP dimension.

Bozok Tıp Derg 2025;15(4):420-429
Bozok Med J 2025;15(4):420-429

Anatomical distribution showed that 74.3% of lesions (n=168) were localized to the 4th finger, 23.9% (n=54) to the 5th finger, with 3rd finger being uncommon (1.8%, n=4). Extension to flexor tendons or muscle structures was present in 52.4% of patients (n=118). Flexion deformity was observed in 42.9% of patients (n=97) (Figure 3).

Demographic, clinical, and lesion characteristics are described in table 1.

A significant positive correlation was identified

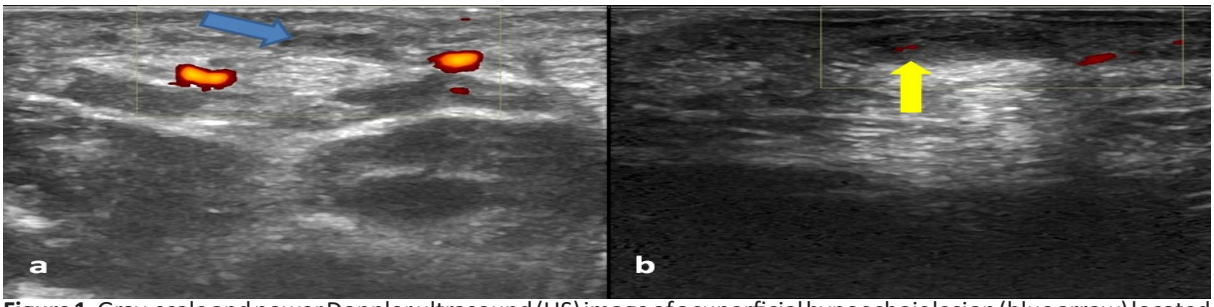


Figure 1. Gray-scale and power Doppler ultrasound (US) image of a superficial hypoechoic lesion (blue arrow) located on the palmar aspect of the right hand in one patient, showing no vascular flow(a). In a different patient, a hypoechoic lesion (yellow arrow) in the left third finger demonstrates mild internal vascularity on power Doppler US (b).

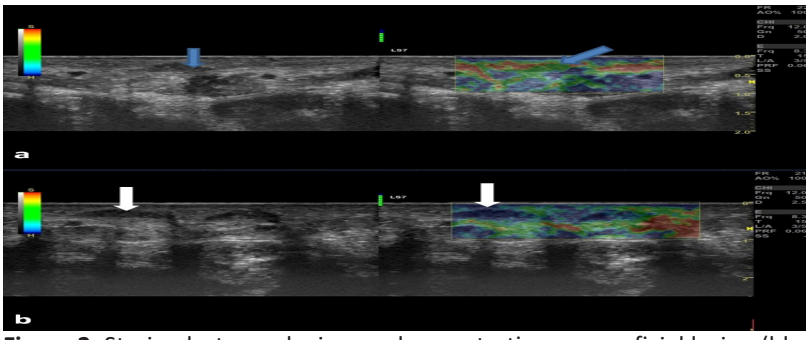


Figure 2. Strain elastography image demonstrating a superficial lesion (blue arrows) on the palmar aspect of the right hand, exhibiting predominantly green coloration suggestive of intermediate stiffness (a). A separate case shows a hypoechoic lesion (white arrows) in the third ray of the left hand with predominantly blue coloration on strain elastography, consistent with increased stiffness (b).

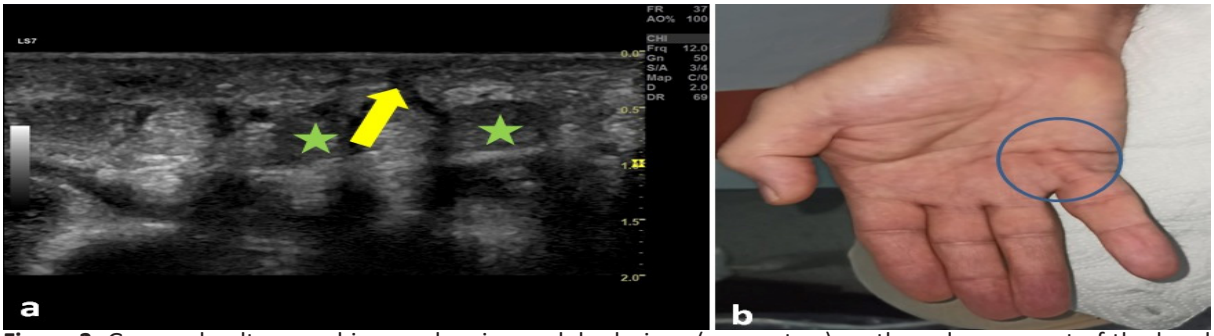


Figure 3. Gray-scale ultrasound image showing nodular lesions (green stars) on the palmar aspect of the hand with spiculated extensions toward the skin (yellow arrow) (a). A flexion contracture caused by the lesion is demonstrated in the same patient (blue circle) (b).

Bozok Tıp Derg 2025;15(4):420-429
Bozok Med J 2025;15(4):420-429

Table 1. Demographic, Clinical, and Lesion Characteristics of Patients with Dupuytren's Disease

Parameter	Category	n (%)
Sex	Female	73 (32.3%)
	Male	153 (67.7%)
Age (mean ±SD) years	Female	62.12 ± 10.96
	Male	61.15 ± 9.40
	Overall	61.46 ± 9.9
Side	Right	134 (59.3%)
	Left	92 (40.7%)
Diabetes	No	149 (65.9%)
	Yes	77 (34.1%)
Smoking	No	186 (82.3%)
	Yes	40 (17.7%)
Epilepsy	No	225 (99.6%)
	Yes	1 (0.4%)
Alcohol use	No	225 (99.6%)
	Yes	1 (0.4%)
Lesion Localization	3rd finger	4 (1.8%)
	4th finger	168 (74.3%)
	5th finger	54 (23.9%)
Lesion Echogenicity	Hypoechoic	189 (83.6%)
	Iso-hyperechoic	37 (16.4%)
Lesion Type	Nodular	84 (37.2%)
	Cord shape	142 (62.8%)
Flexor tendon/muscle relation	Absent	107 (47.6%)
	Present	118 (52.4%)
Flexion deformity	Absent	129 (57.1%)
	Present	97 (42.9%)
CDUS feature	Absent	223 (98.7%)
	Present	3 (1.3%)
SEL feature	Stiff (hard)	119 (52.7%)
	Moderately stiff	93 (41.2%)
	Soft	14 (6.2%)

CDUS: Color Doppler Ultrasound; SEL: Sonoelastography

between the presence of flexor tendon or muscular extension and AP dimension (p=0.017), indicating that lesions with anatomical extension exhibited larger AP measurements.

A robust relationship was established between lesion morphology and dimensions. Cord-shaped lesions demonstrated significantly larger dimensions in both transverse and AP planes compared to nodular lesions (p<0.001 for both dimensions).

The relationship between lesion size and radiological findings and clinical data is summarized in table 2.

The strongest associations with the development of flexion deformity were observed with flexor tendon or muscle involvement and lesion morphology. Among lesions with such structural extension, 81.5% demonstrated flexion deformity, whereas none of the lesions without extension developed any deformity. This association was statistically significant ($\chi^2 = 149.49$, $p < 0.001$). Additionally, cord-shaped lesions exhibited a significantly higher rate of flexion deformity (66.2%)

Bozok Tıp Derg 2025;15(4):420-429
Bozok Med J 2025;15(4):420-429

compared to nodular lesions (3.6%) (p<0.001).

Male patients demonstrated significantly higher rates of flexion deformity compared to females (49.0% vs 30.1%, p=0.007). Furthermore, patients with flexion deformity presented with significantly larger AP dimensions and advanced age (p=0.001 and p=0.008, respectively).

A significant relationship was established between lesion localization and flexion deformity development (p=0.006). The highest rate of flexion deformity was observed in the 4th finger (59.3%), while the lowest rate occurred in the 3rd finger (0.0%). Lesions in the4th finger demonstrated a flexion deformity rate of 38.7%.

Iso-hyperechoic lesions exhibited significantly higher rates of flexion deformity compared to hypoechoic lesions (59.5% vs 39.7%, respectively, p=0.026).

Other comparative findings are summarized in table 3.

4th finger demonstrated a flexion deformity rate of 38.7%.

Iso-hyperechoic lesions exhibited significantly higher rates of flexion deformity compared to hypoechoic lesions (59.5% vs 39.7%, respectively, p=0.026).

Other comparative findings are summarized in table 3.

A strong positive correlation was identified between

Table 2. Lesion Dimensions by Clinical and Sonographic Characteristics

Lesion Dimension	Variable	Group	Mean ± SD (mm)	Mean Rank	p-value
Transverse	Sex	Female	10.94 ± 6.83	105.47	.229
		Male	11.02 ± 5.66	116.62	
Anterior-Posterior		Female	4.49 ± 3.06	96.32	.043*
		Male	4.95 ± 2.83	114.59	
Transverse	Lesion Echogenicity	Hypoechoic	11.35 ± 6.21	116.73	.053
		Iso-hyperechoic	9.21 ± 4.87	94.07	
Anterior-Posterior		Hypoechoic	4.90 ± 3.08	108.84	.855
		Iso-hyperechoic	4.25 ± 1.66	106.71	
Transverse	Lesion Type	Nodular	9.28 ± 4.84	91.70	<.001*
		Cord shape	12.01 ± 6.47	125.69	
Anterior-Posterior		Nodular	4.02 ± 2.92	85.04	<.001*
		Cord shape	5.29 ± 2.80	123.43	
Transverse	Flexor Tendon/Muscle Extension	No extension	10.44 ± 5.13	108.57	.331
		Extension present	11.50 ± 6.76	117.02	
Anterior-Posterior		No extension	4.56 ± 3.22	98.03	.017*
		Extension present	5.02 ± 2.58	118.41	
Transverse	Flexion Deformity	No	10.31 ± 5.03	107.03	0.111
		Yes	12.48 ± 7.22	121.02	
Anterior-Posterior		No	4.47 ± 3.10	96.68	<0.001*
		Yes	5.30 ± 2.55	125.37	
Transverse	Vascularization in CDUS	No	10.91 ± 5.90	112.48	0.304
		Yes	17.60 ± 13.55	110.75	
Anterior-Posterior		No	4.80 ± 2.92	108.48	0.959
		Yes	4.40 ± 2.26	110.75	
Transverse	SEL	Stiff (Hard)	11.59 ± 6.1	111.83	0.118
		Moderately Stiff and Soft	10.43 ± 5.7	98.61	
Anterior-Posterior		Stiff (Hard)	4.66 ± 2.59	100.59	0.797
		Moderately Stiff and Soft	5.00 ± 3.24	102.73	

CDUS: Color Doppler Ultrasound; SEL: Sonoelastography; SD: Standart deviation Note: Mean ± SD values are calculated per group based on actual lesion measurements. Mean Rank values are derived from Mann–Whitney U tests. Statistically significant p-values are shown in bold.

Bozok Tıp Derg 2025;15(4):420-429
Bozok Med J 2025;15(4):420-429

Table 3. Associations Between Patient and Lesion Characteristics and the Presence of Tendon/Muscle Involvement and Flexion Deformity

Comparison	Group/Category	Positive Finding Rate (%)	χ^2 / p value
Sex vs Tendon/Muscle Involvement	Female	43.8	3.364 / 0.067
	Male	56.9	
Affected Side vs Tendon/Muscle Involvement	Right Hand	51.5	0.178 / 0.673
	Left Hand	54.3	
Lesion Localization vs Tendon/Muscle Involvement	3rd finger	25.0	4.004 / 0.135
	4th finger	50.0	
	5th finger	63.0	
Vascularization vs Tendon/Muscle Involvement	Absent	52.9	0.455 / 0.500
	Present	33.3	
Echogenicity vs Tendon/Muscle Involvement	Hypoechoic	50.3	2.646 / 0.104
	Iso-hyperechoic	64.9	
Sex vs Flexion Deformity	Female	30.1	7.193 / 0.007*
	Male	49.0	
Affected Side vs Flexion Deformity	Right Hand	40.3	0.924 / 0.337
	Left Hand	46.7	
Lesion Localization vs Flexion Deformity	3rd finger	0.0	10.119 / 0.006*
	4th finger	38.7	
	5th finger	59.3	
Echogenicity vs Flexion Deformity	Hypoechoic	39.7	4.940 / 0.026*
	Iso-hyperechoic	59.5	
Vascularization vs Flexion Deformity	Absent	43.0	0.114 / 0.736
	Present	33.3	
Tendon/Muscle Involvement vs Flexion Deformity	Absent	0.0	149.49 / <0.001*
	Present	81.5	
Lesion Morphology vs Flexion Deformity	Nodular	3.6	84.493 / <0.001*
	Cord-like	66.2	

χ^2: Chi-square; %: Percentage; p: p-value; Tendon/muscle involvement refers to lesion extension to adjacent flexor tendons or muscle structures.

transverse and anterior-posterior lesion dimensions (Spearman's ρ=0.631, p<0.001). This finding indicates that larger lesions tend to demonstrate growth in both dimensional planes, suggesting uniform expansion patterns in advanced disease stages.

DISCUSSION

This study analyzed various sonographic features of DD lesions (echogenicity, lesion size, flexor tendon or muscle extension, strain elastography-based stiffness, and CDUS vascularity) to exploretheir associations with the occurrence of flexion contractures. Demographic variables, including age, sex, and relevant etiologic factors, were also examined in relation to the imaging characteristics observed.

Our findings showed a male predominance (male/female ratio = 2.1:1), which aligns with previous studies. Literature reports indicate that men are affected approximately twice as often as women, with a more aggressive disease course in males. Some publications indicate that male predominance is less pronounced than previously thought and that this ratio changes with age (13). Furthermore, earlier disease onset is associated with increased severity of disease progression (14).

The observation that AP lesion dimensions were significantly greater in male patients carries clinical relevance (p=0.043). This finding supports the

hypothesis that the disease exhibits a more aggressive course in males. According to existing literature, DD in males tends to have earlier onset, advances more rapidly, and recurs more frequently (15). The notably higher frequency of flexion deformity in male patients observed in our study may represent a clinical manifestation of the disease's more severe course in this group (p=0.007). Hormonal mechanisms are thought to contribute significantly to these sex-based differences in disease severity. It has been suggested that estrogen exerts a protective influence in females, whereas testosterone may promote fibrous tissue proliferation in males (16). The increase in DD prevalence among women in the postmenopausal period further supports the hormonal hypothesis.

Moreover, the significantly older age of patients presenting with flexion deformity reflects the chronic and progressive character of DD (p=0.008). This observation suggests that age may serve as an independent prognostic indicator and underscores the value of early recognition and treatment.

A notable finding in our study was that lesions with cord-like morphology were significantly larger in both transverse and anteroposterior dimensions than those with a nodular pattern (p<0.001 for both). This result highlights the potential prognostic value of lesion morphology in staging the disease and anticipating its progression. Vanek et al. reported that identifying cord morphology on ultrasound may assist in predicting post-treatment outcomes (17). Aligned with their findings, our study also revealed a strong prognostic association between lesion morphology and contracture, with a 66.2% deformity rate in cord-shaped lesions versus just 3.6% in nodular ones (p<0.001). This disparity likely reflects distinct phases in the disease's underlying pathogenesis. The nodular phase is dominated by myofibroblast activity and TGF-β signaling, whereas the cord phase is characterized by mature collagen deposition and contracture formation (6, 18). Thus, the high rate of flexion deformity in cord-like lesions suggests that this morphological transformation serves as a strong marker of functional compromise.

One of the strongest findings of our study is that while flexion deformity was observed in 81.3% of lesions with tendon and/or muscular extension, no deformity was detected in any lesions without extension (p<0.001). This dramatic result demonstrates that anatomical proximity is the most critical factor determining the clinical course of the disease. Consistent with our findings, previous anatomical and ultrasonographic studies have suggested that the close spatial relationship between Dupuytren lesions and flexor tendons may mechanically contribute to the development of flexion deformities (8, 19). Therefore, evaluating tendon involvement via preoperative ultrasonography may provide valuable insight for surgical risk stratification and for informing patients.

Analysis based on lesion localization revealed that flexion deformity occurred in 59.3% of cases involving the 5th finger and 38.7% of those affecting the 4th finger (p=0.006), indicating that anatomical site plays a prognostic role. This difference may be attributable to anatomical features of the fourth intermetacarpal space, which may predispose to flexor tendon compression. Prior studies have shown that DD most commonly and severely affects the 4th and 5th digits (20). Our finding supports this knowledge while also demonstrating that US determination of localization has prognostic value.

Our finding of no statistically significant correlation between lesion stiffness on SEL and lesion size ($p > 0.05$) is particularly notable. Currently, no studies in the literature have demonstrated a direct correlation between elastographic stiffness and lesion size; existing reports primarily focus on using SEL to characterize lesion consistency and morphology, such as nodular versus cord types (21). Variations in technique and patient selection criteria may account for these inconsistent results. Despite these limitations, we consider our findings to offer original insights that may enrich the current literature. Future multicenter studies with larger patient populations could further validate these results.

The more frequent occurrence of flexion deformity in iso-hyperechoic lesions suggests a relationship between echogenicity and disease activity (p=0.026). Molenkamp et al. found that hypoechoic nodules observed on ultrasound correlate with increased myofibroblast content on histopathologic examination ($r \approx -0.4$; $p = 0.002$) (22). This finding suggests that echogenicity may be an imaging biomarker reflecting nodule activity.

The very low number of patients with vascularization detected by CDUS (1.3%) and the lack of significant relationship with clinical findings suggest that CDUS has limited value in this disease. This aligns with existing knowledge that the contracture phase of DD is dominated by avascular fibrous structures (23). Nonetheless, increased vascularity has been reported during the early nodular stage of the disease (23). This discrepancy may be attributed to the fact that most patients in our study were in more advanced disease stages.

In contrast to previous studies primarily describing the descriptive sonographic features of Dupuytren's disease, our research focuses on quantifying the associations between imaging findings and the development of flexion deformity. This approach provides practical prognostic information that may aid clinicians in stratifying patients based on deformity risk.

Our study has several limitations. Its retrospective design, absence of follow-up data, and lack of standardization in elastographic evaluation are the main constraints. Additionally, the low positivity of CDUS makes interpretation of results related to this modality challenging.

CONCLUSION

Ultrasonography and elastography offer significant prognostic insight in the management of Dupuytren's contracture. Among the evaluated variables, flexor tendon involvement stands out as the most reliable predictor of contracture development. In addition, cord-like lesion morphology, male sex, and localization to the fourth finger were found to be relevant clinical risk factors. These results may serve as a foundation for more accurate risk stratification and individualized treatment planning, allowing clinicians to make better-informed decisions regarding surgical strategies and patient communication. Routine incorporation of standardized ultrasound protocols into clinical workflows is recommended to improve patient outcomes in the treatment of this condition.

Acknowledgment

The author declared that this study has received no financial support.

REFERENCES

1. Dutta A, Jayasinghe G, Deore S, Wahed K, Bhan K, Bakti N, et al. Dupuytren's contracture–current concepts. J Clin Orthop Trauma. 2020;11(4):590-6.

2. Lanting R, Broekstra DC, Werker PM, van den Heuvel ER. A systematic review and meta-analysis on the prevalence of Dupuytren disease in the general population of Western countries. Plast Reconstr Surg. 2014;133(3):593-603.

3. Grazina R, Teixeira S, Ramos R, Sousa H, Ferreira A, Lemos R. Dupuytren's disease: where do we stand? EFORT Open Rev. 2019;4(2):63-9.

4. Alser OH, Kuo RY, Furniss D. Nongenetic factors associated with Dupuytren's disease: a systematic review. Plast Reconstr Surg. 2020;146(4):799-807.

5. Broekstra DC, Groen H, Molenkamp S, Werker PM, van den Heuvel ER. A systematic review and meta-analysis on the strength and consistency of the associations between Dupuytren disease and diabetes mellitus, liver disease, and epilepsy. Plast Reconstr Surg. 2018;141(3):367e-79e.

6. Sayadi LR, Alhunayan D, Sarantopoulos N, Kong C, Condamoor S, Sayadi J, et al. The molecular pathogenesis of Dupuytren disease: review of the literature and suggested new approaches to treatment. Ann Plast Surg. 2019;83(5):594-600.

7. Rayan GM. Dupuytren disease: anatomy, pathology, presentation, and treatment. JBJS. 2007;89(1):189-98.

8. Morris G, Jacobson JA, Kalume Brigido M, Gaetke-Udager K, Yablon CM, Dong Q. Ultrasound features of palmar fibromatosis or Dupuytren contracture. J Ultrasound Med. 2019;38(2):387-92.

9. Molenkamp S, van Straalen RJ, Werker PM, Broekstra DC. Imaging for Dupuytren disease: a systematic review of the literature. BMC Musculoskelet Disord. 2019;20(1):224.

10. Botar Jid C, Vasilescu D, Damian L, Dumitriu D, Ciurea A, Dudea SM. Musculoskeletal sonoelastography. pictorial essay. Med Ultrason. 2012;14(3):239-45.

11. Murphey MD, Ruble CM, Tyszko SM, Zbojniewicz AM, Potter BK, Miettinen M. Musculoskeletal fibromatoses: radiologic-pathologic correlation. Radiography. 2009;29(7):2143-83.

12. van den Berge BA, Werker PM, Broekstra DC. Limited progression of subclinical Dupuytren's disease: results from a prospective cohort study. Bone Joint J. 2021;103(4):704-10.

13. Anthony SG, Lozano-Calderon SA, Simmons BP, Jupiter JB. Gender ratio of Dupuytren's disease in the modern US population. Hand. 2008;3(2):87-90.

14. Walthall J, Anand P, Rehman U. Dupuytren Contracture. [Updated 2023 Feb 26]. StatPearls [Internet] Treasure Island (FL): StatPearlsPublishing. 2024.

15. Sarkar M, Kashyap N, Madabhavi I. Dupuytren’s disease: a review. Chin J Plast Reconstr Surg. 2024;6:142-8.

16. Stahl S, Calif E. Dupuytren's palmar contracture in women. Isr Med Assoc J. 2008;10(6):445.

17. Vanek P, Strömberg J, Fridén J, Aurell Y. Morphological patterns of the pretendinous cord in Dupuytren’s disease: a predictor of clinical outcome? J Plast Surg Hand Surg. 2018;52(4):240-4.

18. Lambi AG, Morrell NT, Popoff SN, Benhaim P, Barbe MF. Let’s focus on the fibrosis in Dupuytren Disease: cell communication network factor 2 as a novel target. J Hand Surg Glob Online. 2023;5(5):682-8.

19. Crowley B, Tonkin MA. The proximal interphalangeal joint in Dupuytren's disease. Hand clinics. 1999;15:137-48.

20. Lanting R, Nooraee N, Werker PM, van den Heuvel ER. Patterns of Dupuytren disease in fingers: studying correlations with a multivariate ordinal logit model. Plast Reconstr Surg. 2014;134(3):483-90.

21. Ulusoy A, Tikiz C, Örgüç Ş. Dupuytren’s contracture with rare bilateral thumb and little finger involvement demonstrated by ultrasound elastography. Arch Rheumatol. 2015;30(4):357-60.

22. Molenkamp S, Song W, Bloembergen M, Broekstra DC, Werker PM. Echogenicity of Dupuytren’s nodules is correlated to myofibroblast load and nodule hardness. J Hand Surg (European Volume). 2022;47(3):280-7.

23. Rehman S, Goodacre R, Day PJ, Bayat A, Westerhoff HV. Dupuytren's: a systems biology disease. Arthritis Res Ther. 2011;13(5):238.