

# The analysis of morphological features and ultrasonographic characteristics of Dupuytren's disease

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## Abstract

**Objectives:** To detect B-Mode ultrasonography, color Doppler ultrasonography, and sonoelastography findings of the Dupuytren's disease, and to determine the differences of sonographic imaging, demographic and clinical data.

**Methods:** A total of 88 patients with unilateral lesion were included. Each lesion was evaluated with B-Mode ultrasonography, color Doppler ultrasonography, and sonoelastography. The location, size, morphology, and echogenicity of the lesions were analyzed by B-mode ultrasonography, the presence of vascularization by color Doppler ultrasonography, and the elasticity by sonoelastography, retrospectively. The differences between sonographic findings, demographic and clinical data were evaluated.

**Results:** Of the patients, 36.4% were women and 63.6% were men, with a median age of 61 (interquartile range: 9). The majority of the lesions (87.5%) were at the level of the 3rd and 4th finger/metacarpal. Median longitudinal dimension was 6.75mm (interquartile range: 4.32), mediolateral dimension was 2.5 mm (interquartile range: 1.77). Of the lesions, 67.1% were nodular shaped, 73.9% were hypoechoic, and 87.5% were hypovascular. All lesions were hard coded on sonoelastography. The cord morphology, extension to the tendon, and contracture tend to be together, and lesions with these were mostly iso-hyper-echoic.

**Conclusion:** Dupuytren's disease lesions were mostly nodular, hypoechoic, hypovascular, and stiff. Ultrasonographic examination was sufficient and successful in the diagnosis of Dupuytren's disease.

**Keywords:** color doppler ultrasonography; Dupuytren's disease; morphology; sonoelastography; ultrasonography

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## Introduction

Dupuytren's disease (DD) is a benign fibroblastic proliferation of palmar aponeurosis.<sup>[1]</sup> It is the most common superficial fibromatosis and affects 1–2% of the population.<sup>[2]</sup> Its frequency is geographically and racially distributed, most common in northern Europe.<sup>[3]</sup> The frequency of DD increases in the elderly population and reaches 20% over the age of 65.<sup>[3]</sup> Male dominance is present, it is not uncommon to be bilateral.<sup>[2]</sup> Another name is palmar fibromatosis, and Dupuytren's contracture terminology is used in cases with flexion contracture at the fingers.<sup>[4,5]</sup> Clinically, there are palpable painless subcutaneous nodules on the palmar face.<sup>[1]</sup> It can grow over the years and cause retraction of the tendons, causing flexion contracture

of the fingers. It is often located at the level of the 4th and 5th metacarpal.

Although the etiology has not been clearly revealed, some reasons have been accepted. Trauma, smoking, microvascular damage, antiepileptic use, immunological and genetic factors are some of them.<sup>[3]</sup> Fibrogenic cytokines such as fibroblast growth factor, wntless/integrated, and transforming growth factor beta released in various causes are the main cause of the disease.<sup>[6]</sup> Therefore, DD can be seen together with other superficial fibromatoses, plantar fibromatosis (Ledderhose disease) and Peyronie's disease.<sup>[3]</sup>

The diagnosis can usually be made easily with typical lesion localization and physical examination. Since the

differential diagnosis includes tenosynovitis, trigger finger, ganglion cyst, and other soft tissue masses, imaging should be performed even if the diagnosis is clinical. In addition, with imaging methods, information about the three dimensions of the lesion can be obtained and its relationship with adjacent tendons and neurovascular bundles can be evaluated.<sup>[7]</sup> B-mode ultrasonography (US) is the first choice and easily accessible imaging method in superficial lesions. With US, the solid or cystic nature of the lesion can be distinguished. Its vascularity can be detected with Color Doppler US (CDUS). Sonoelastography (SEL) is a current and popular modality that provides additional contributions to tendon, ligament, muscle, and superficial masses in musculoskeletal sonographic examination.<sup>[8,9]</sup> On SEL, the stiffness of the tissues is coded in a color scale from blue to red and transmitted to the observer. In addition to qualitative examination, quantitative stiffness measurement can be made. Superficial lesions in DD are also an ideal target for SEL examination.

There is no specific treatment for DD. Methods such as rest, topical agents, steroid injections can be tried.<sup>[3]</sup> Lesions can be excised surgically, but since 30–40% may show recurrence, it is not preferred if there is no flexion contracture or lesion affecting daily life. The presence of a flexion contracture greater than 20 degrees in the metacarpophalangeal joint and 30 degrees in the proximal interphalangeal joint is an indication for surgery.<sup>[10]</sup> For these reasons, treatment should be personalized on a patient basis. Therefore, imaging methods, especially ultrasound, are important in guiding the treatment. At the same time, minimally invasive treatments can be performed with ultrasound guidance (e.g., intralesional injection) and can be easily used in treatment follow-up.<sup>[7]</sup>

Our aim in this study was to describe the US, CDUS and SEL imaging findings of DD lesions and to investigate whether these findings are differ from each other. At the same time, the differences between ultrasonographic findings and patient demographic and physical examination data was investigated.

## Materials and Methods

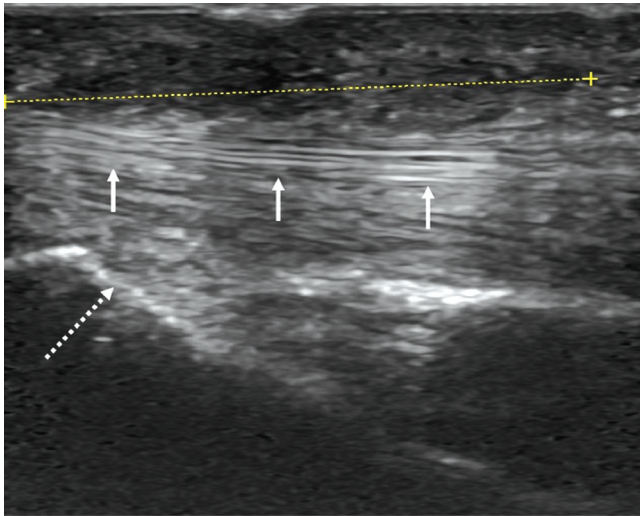
The reports and recorded cine images of ultrasonographic examinations performed with the preliminary diagnosis of DD between June 2020 and June 2022 were retrospectively reviewed. These reports and images were reanalyzed retrospectively by a radiologist with 12 years of musculoskeletal US experience. Only patients with unilateral lesions were included in the study. In patients with multiple lesions, the dominant lesion was included. In addition, the clinical and physical examination findings of the

patients were examined. Patients with rheumatologic disease, diagnosis of malignancy, undergoing hand surgery and a history of hand trauma were excluded.

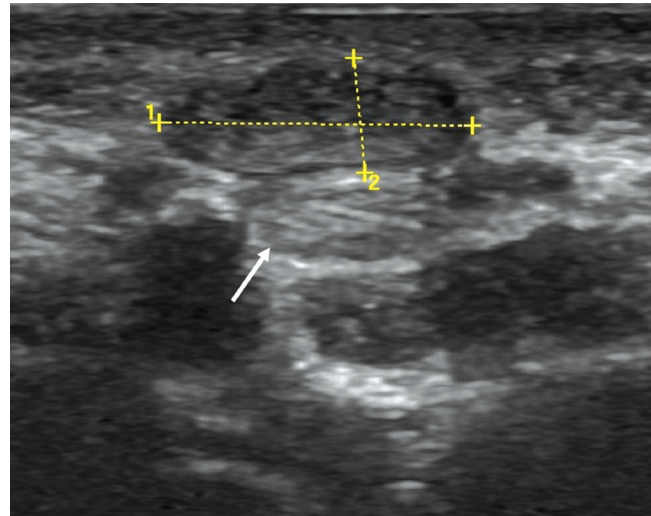
Ultrasound examination was performed while the patient was sitting, with the hand in supination in contact with the anterior thigh. The dimensions of the lesions in the transverse and longitudinal planes were measured. In all cases, B-Mode US, CDUS, and SEL examinations were performed separately for each lesion by the same radiologist, images were recorded and reported. Evaluation was done with a high resolution 5–11 MHz linear probe (GE Logiq S7 Expert, GE Healthcare, Milwaukee, WI, USA). The presence of vascularization in the lesions was evaluated in CDUS. Simultaneously, SEL examination of the lesions was performed with the same position and probe. Tissue elasticity under light compression and decompression with a probe on the lesion was evaluated according to the real-time color map on the B-Mode US image. On SEL, soft structures were coded in red, medium-hard structures in yellow, and hard structures in green and blue.

The presence of nodules or cords of DD, in which finger they were located, their size, echogenicity, extension to the flexor tendon, the presence of intralesional vascularization on CDUS, and the elasticity characteristics of the lesions on SEL were evaluated. The size of the lesions in the transverse and longitudinal planes were electronically measured on B-mode US with calipers. The echogenicity of the lesion was compared with the adjacent tendon and determined as hypoechoic, isoechoic, and hyperechoic. The extension to the flexor tendon defines the focal areas of extension of the lesions to both flexor digitorum superficialis and flexor digitorum profundus tendons. The presence of intralesional vascularization means colored areas in the lesion on CDUS examination. The elasticity characteristics of the lesions were classified on a soft to hard scale according to the color coding on the SEL examination.

Statistical analysis was performed with IBM SPSS Statistics Version 22.0 (Armonk, NY, USA) with 95 % confidence interval. The normal distribution of the quantitative variables was evaluated using the Shapiro Wilk normality test. Because the data is not normally distributed, the distribution of variables was evaluated with the chi-square test or the Mann-Whitney U test. The differences of anatomical variations were evaluated with the Mann-Whitney U test. Medians and interquartile ranges (IQR) were given because of the non-parametric tests. Results of  $p < 0.05$  were considered significant.



**Figure 1.** Hypoechoic solid nodule (longitudinal axis) of Dupuytren's disease. The dashed line indicates the longitudinal dimension of the nodule. The nodule is located in the subcutaneous tissue in the superficial neighborhood of the flexor digitorum tendons (arrows). In the deepest part, the metacarpal is observed (dashed arrow).



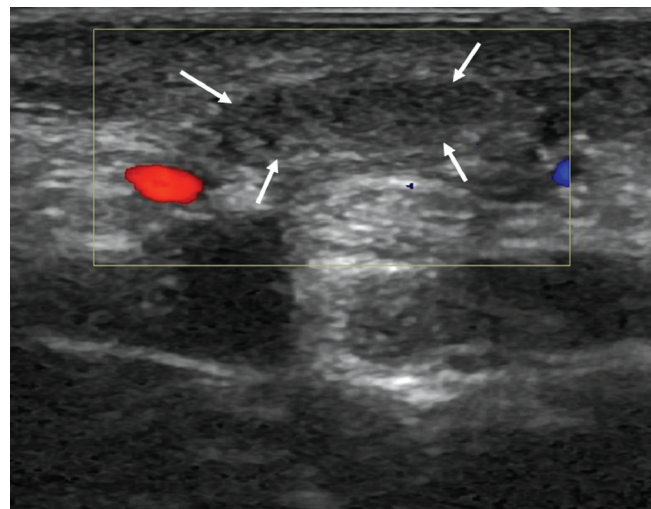
**Figure 2.** Hypoechoic solid nodule (transversal axis) of Dupuytren's disease. The dashed lines indicate the mediolateral and anteroposterior dimensions of the nodule. The nodule is located in the subcutaneous tissue in the superficial neighborhood of the flexor digitorum tendons (arrows).

## Results

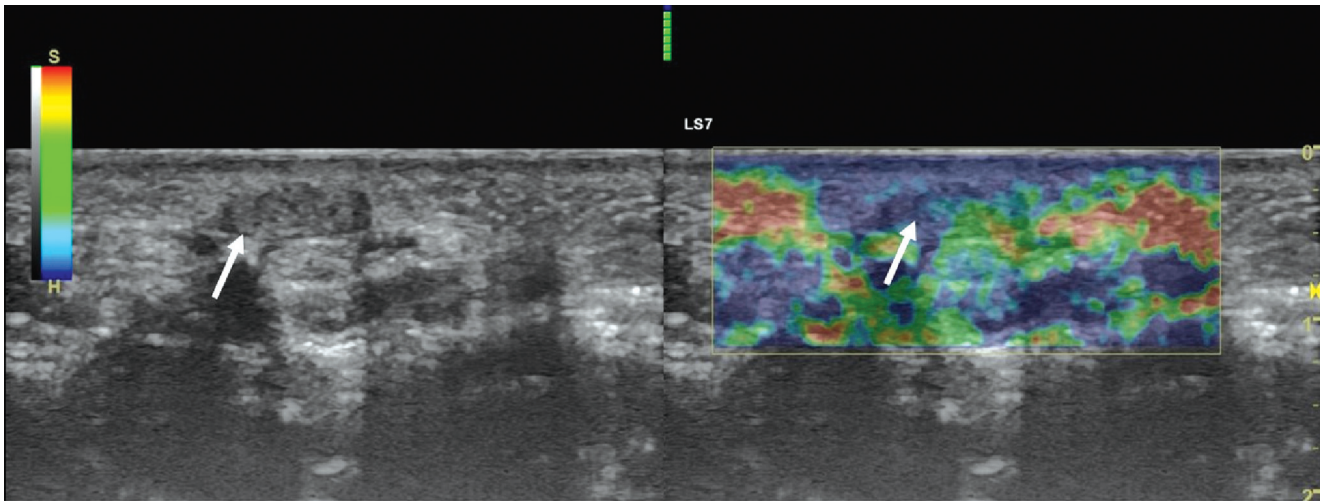
There were 88 patients (median age 61, IQR 9) meeting the study criteria. Of the patients, 32 (36.4%) were women and 56 (63.6%) were men. Fifty-six (63.5%) of the lesions were on the right hand and 32 (36.4%) on the left hand. There were 1 (1.1%) lesion in the 1st finger, 5 (5.7%) in the 2nd finger, 17 (19.3%) in the 3rd finger, 60 (68.2%) in the 4th finger, and 5 (5.7%) in the 5th finger. The lesion location ranged from the metacarpal body proximally to the middle phalanx distally. The median longitudinal dimension was 6.75mm (IQR: 4.32) and the median transverse dimension was 2.5mm (IQR: 1.77). On B-mode US examination, the lesions were hypoechoic in 65 (73.9%) patients and iso-hyperechoic in 23 (26.1%) patients (Figures 1 and 2). Lesions were nodules in 59 (67.1%) patients, and cord-shaped in 29 (32.9%) patients. Out of the total number of the patients, extension to the flexor tendon was present in 73 (82.9%) while the contracture was noted in 20 (22.7%) cases. The vascularization was present in 11 (12.5%) of the patients (Figure 3). On SEL examination, blue-green coding was found in 50 (56.8%) patients, and only blue coding was found in 38 (43.2%) patients (Figure 4). In the clinical and physical examination records of the cases included in the study, there were long-standing palpable painless stiffness in the palmar region or stiffness causing flexion deformity in the finger.

The distribution of numerical data in categorical variable groups was given in the Table 1.

There was a significant difference between lesion echogenicity and cord and contracture. Of the hypoechoic lesions, 50 have no cords and 15 have cords; of the iso-hyperechoic lesions, 9 had no cord, and 14 had cords ( $p=0.001$ ). In addition of the hypoechoic lesions, 54 had no contracture and 11 had contractures; of the iso-hyperechoic lesions, 14 had no contracture and 9 had contracture ( $p=0.029$ ). However, there was no significant relationship between lesion echogenicity and gender, side, localization, extension to the tendon, CDUS, and



**Figure 3.** On the color Doppler ultrasonography examination, vascularity is not observed in the hypoechoic nodule (arrows).



**Figure 4.** On sonoelastography, the hypoechoic nodule was coded blue-green (arrow), and the adjacent soft tissues were predominantly red-orange coded. Blue-green color coding indicates that the Dupuytren's disease nodule is stiff.

SEL ( $p=0.854$ ,  $p=0.854$ ,  $p=0.271$ ,  $p=0.553$ ,  $p=0.660$ , and  $p=0.648$ , respectively).

There was a significant difference between the presence of the cord and echogenicity, extension to the tendon and contracture. Of the nodular lesions, 50 were hypoechoic and 9 were iso-hyperechoic; of the cord-shaped lesions, 15 were hypoechoic and 14 were iso-hyperechoic ( $p<0.001$ ). All 29 cord-shaped lesions had extension to the tendon, however, of the nodular lesions, 44 had extension to the tendon, 15 did not ( $p<0.001$ ). While there was no contracture in any of the 59 nodular lesions, there were no

contractures in 9 of the cord-shaped lesions and in 20 of them ( $p<0.001$ ). No significant difference was found between the presence of cord and gender, side, location, CDUS and SEL ( $p=0.189$ ,  $p=0.357$ ,  $p=0.153$ ,  $p=0.265$ , and  $p=0.258$ , respectively).

There was a significant difference between extension to the tendon and the presence of contracture and cord. Of the lesions with extension, 20 had contracture, 53 did not; none of the 15 lesions without extension had contractures ( $p=0.021$ ). In addition, 29 lesions with extension had cord and 44 did not. There was no cord in any of the 15 lesions

**Table 1**

Distribution of numerical data in categorical variable groups. Data are given as "median (interquartile range)".

	Age (year)		Longitudinal dimension (mm)		Transversal dimension (mm)	
<b>Gender</b>	Women: 59 (mean age:12) Men: 61 (9)	$p=0.191$	Women: 5.8 (3.6) Men: 7.3 (4.7)	$p=0.013$	Women: 1.95 (1.6) Men: 2.8 (2.1)	$p=0.001$
<b>Side</b>	Right: 62 (9) Left: 59 (14)	$p=0.142$	Right: 5.9 (3.9) Left: 7 (4.1)	$p=0.215$	Right: 2.4 (2.1) Left: 2.6 (1.5)	$p=0.435$
<b>Echogenicity</b>	Hypo: 60 (10) Iso-hyper: 65 (9)	$p=0.129$	Hypo: 7.0 (4.7) Iso-hyper: 5.6 (4.1)	$p=0.012$	Hypo: 2.4 (1.4) Iso-hyper: 2.9 (2.2)	$p=0.043$
<b>Cord</b>	Yes: 63 (7) No: 59 (12)	$p=0.026$	Yes: 5.6 (4.4) No: 7 (4.3)	$p=0.291$	Yes: 2.4 (1.4) No: 4.2 (4.1)	$p<0.001$
<b>Extension</b>	Yes: 61 (11) No: 66 (11)	$p=0.129$	Yes: 7 (5.3) No: 6.4 (4.1)	$p=0.991$	Yes: 2.5 (1.7) No: 2.5 (2.2)	$p=0.362$
<b>Contracture</b>	Yes: 62.5 (8) No: 60.5 (10)	$p=0.326$	Yes: 6.3 (5.2) No: 6.75 (3.8)	$p=0.580$	Yes: 5.1 (6.8) No: 2.4 (1.3)	$p<0.001$
<b>CDUS</b>	Yes: 57 (12) No: 61 (10)	$p=0.289$	Yes: 6.3 (3.9) No: 6.8 (4.4)	$p=0.972$	Yes: 2.2 (3.1) No: 2.5 (1.8)	$p=0.502$
<b>SEL</b>	Blue: 62 (8) Green Blue: 59 (12)	$p=0.024$	Blue: 5.9 (4.6) Green Blue: 7 (3.9)	$p=0.474$	Blue: 2.8 (2.3) Green Blue: 2.45 (1.7)	$p=0.899$

without extension ( $p=0.012$ ). No significant difference was found between extension to the tendon and gender, side, location, echogenicity, CDUS and SEL ( $p=0.789$ ,  $p=0.748$ ,  $p=0.453$ ,  $p=0.553$ ,  $p=0.703$ , and  $p=0.765$ , respectively).

There was a significant difference between the presence of contracture and gender, echogenicity, the presence of a cord, and extension to the tendon. Eighteen of the contracture cases were man and 2 were woman; 38 of the non-contracted cases were man and 30 were woman ( $p=0.005$ ). Of the lesions with contracture, 11 were hypoechoic and 9 were iso-hyperechoic; of the non-contracted lesions, 54 were hypoechoic and 14 were iso-hyperechoic ( $p=0.029$ ). A cord was present in all 20 lesions with contracture, while 9 of non-contracted lesions had cord and 59 had no cord ( $p<0.001$ ). All 20 lesions with contracture had extension to the tendon, while 53 of non-contracted lesions had extension and 15 did not ( $p=0.021$ ). There was no significant difference between the presence of contracture and side, location, CDUS and SEL ( $p=0.701$ ,  $p=0.530$ ,  $p=0.157$ , and  $p=0.852$ , respectively).

There was a significant difference between the vascularization of the lesion and the cord and side. Of the lesions without vascularization, 50 had no cord, and 27 had cords; of the lesions with vascularization, 9 had no cord and 2 had cords ( $p<0.001$ ). In the lesions on the right hand, vascularity was absent in 45 patients and present in 11 patients; on the left hand, vascularity was present in all 32 lesions ( $p=0.028$ ). There was no significant difference between vascularization and gender, localization, echogenicity, extension to the tendon, contracture, and SEL ( $p=0.497$ ,  $p=0.071$ ,  $p=0.660$ ,  $p=0.703$ ,  $p=0.157$ , and  $p=0.257$ , respectively).

There was a significant difference between lesion elasticity and the side. 29 of the lesions with blue coding were on the right and 9 were on the left, 27 of the lesions with blue-green coding were on the right and 23 were on the left ( $p=0.031$ ). There was no significant difference between lesion elasticity and gender, localization, echogenicity, extension to the tendon, cord, contracture and CDUS ( $p=0.207$ ,  $p=0.563$ ,  $p=0.648$ ,  $p=0.765$ ,  $p=0.258$ ,  $p=0.852$ , and  $p=0.257$ , respectively).

## Discussion

In this study, we revealed the ultrasonographic morphology, CDUS and SEL findings of palmar lesions in DD and also investigated their differences with each other. We revealed that men have larger lesions and contracture more frequently, hypoechoic lesions are larger but have fewer cords and contractures, older patients have more cord morphology and more stiff lesions, the mediolateral

dimension is greater in the presence of the cord and contracture, the vascularity is less in the cord morphology, the extension and contracture to the tendon is more in the cord morphology, and the contracture is more frequent in the lesions with extension to the tendon.

From these results, it can be interpreted that cord morphology, tendon extension and contracture parameters tend to be together, and lesions with these parameters are mostly iso-hyperechoic and hypovascular. Accordingly, in the presence of late signs such as contracture, the increase in echogenicity and decrease in vascularity support the increase in intralesional fibrotic tissue. In the presence of more hypoechoic and vascular lesions, early-stage DD can be considered, and treatment can be personalized accordingly.

Although the diagnosis of DD is usually made clinically, histopathological correlation may rarely be required. Distal volar localized nodules in the subcutaneous soft tissue cause shrinkage of the overlying skin as ageing. It may also result in flexion contracture due to its cord-like, palpable hard structure. Pathology does not include tendon and muscle. On ultrasound, nodules or cordlike lesions in DD may vary in scale from hypoechoic to iso-hyperechoic to tendons. However, it is generally hypoechoic compared to tendons. On CDUS, its vascularity changes, but it is mostly hypovascular. It is an important advantage that the relationship of the lesions with the tendons can be evaluated on US in real time, and it enables the exclusion of tendinous lesions in the differential diagnosis.

In the study of Morris et al.,<sup>[1]</sup> the lesions were detected most frequently in the 3rd and 4th finger localizations. We also detected the majority of our cases (87.5%) at the level of the 3rd and 4th finger/metatarsal. In their study, 98% of the lesions were hypoechoic, and 93% of patients were hypovascular on CDUS. In our study population, again, hypoechoic and hypovascular lesions were more common, but proportionally hypoechoic (73.9%) and hypovascular (87.5%) lesions were less than them.

Cretuer et al.<sup>[11]</sup> stated that early period DD nodules are hypoechoic compared to tendons due to their cellularity, and iso- to hyper-echoic due to the increase in collagen content in the late period. It is stated that cellular, that is, active lesions, have a higher risk of recurrence.<sup>[4,12]</sup> Therefore, determination of lesion cellularity with imaging can be determinative in terms of prognosis and treatment. We have shown that cord morphology and stiffer lesions are common in elderly patients. This can be interpreted as the increase in fibrosis in the lesions in the late period causes the cord morphology and is coded stiffer on SEL. However, Molenkamp et al.<sup>[13]</sup> found that hypo-

echogenicity in nodules was not a predictor of dimensional increase. No significant dimensional increase was found in the nodules that were found to be hypoechoic in their studies compared to the hyperechoic ones in their follow-up 1 year later. We also did not find a significant difference between lesion size and echogenicity.

In the study of Molenkamp et al.,<sup>[14]</sup> a significant negative correlation was found between the echogenicity of the nodule and the myofibroblast load in histopathological examination. In addition, they found a significant negative correlation between echogenicity and hardness in their hardness examination with tonometry. These results prove that cellular nodules are more hypoechoic and stiffer. At the same time, more hypoechoic nodules can be considered to be stiffer. We did not find any significant difference between lesion echogenicity and stiffness on SEL. In the study of Ball et al.,<sup>[15]</sup> nodules were found to be harder than normal tissue in the hardness measurement made by tonometry. In their DD case report, Ulusoy et al.<sup>[16]</sup> described the increase in vascularization and heterogeneity in the thickening of both tendon sheaths and superficial palmar fascia in B-Mode US and CDUS. They interpreted the increase in vascularization as an early sign of nodules. On SEL examination, they found that the nodules were hard coded compared to adjacent soft tissue. They reported that this result supports fibrosis. They suggested that SEL can distinguish between acute and chronic lesions and that the efficacy of treatment can be evaluated according to lesion stiffness. Our study was not a case report, and 88 lesions were evaluated. SEL examination was performed on all lesions, and it was seen that all of them were hard coded. In addition, the lesions of the elderly patients were significantly stiffer.

There were some limitations in our study. The retrospective basis was the main limitation. Mistakes and biases may have occurred in patient selection and evaluation of images. Information from recorded images and report texts may be incomplete. Another limitation is the lack of histopathological diagnosis of the lesions. In none of our patients, lesion excision was not required since there was no excessive contracture that could be an indication for operation and the diagnosis was supported by physical examination and radiological examination. The fact that the lesions were examined by a single evaluator reduces the generalizability of the findings.

## Conclusion

DD lesions is mostly hypoechoic, nodular shaped, hypovascular, and stiff. The cord morphology, tendon extension and contracture are the late stage parameters, and

lesions with these are mostly iso-hyperechoic. In the presence of a solid lesion originating from the subcutaneous soft tissue of the palmar region, DD can be diagnosed by considering the lesion location, morphology, vascularity, and degree of stiffness with a combination of US, CDUS and SEL. The DD lesions can be determined that are in the early or late stage by using morphology, echogenicity, vascularity, and stiffness data. Thus, the success of the treatment can be increased by reducing the recurrence rate.

## Conflict of Interest

No conflict of interest was declared by the authors.

## Author Contributions

AHÇ: project development, data management, data analysis, statistical analysis, manuscript writing/editing; MB: project development, data collection, data analysis, manuscript writing/editing.

## Ethics Approval

The study was approved by Ankara City Hospital Clinical Research Ethics Committee (No: E2-20-76, Date: 30.12.2020). The study was also carried out in accordance with the Helsinki Declaration of Principles.

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