THE INVESTIGATION OF RADIOLOGICAL FINDINGS AND UPPER EXTREMITY FUNCTIONS IN DIFFERENT AGE PATIENTS WITH DEGENERATIVE ROTATOR CUFF TEARS

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ABSTRACT

Clinical outcomes and upper extremity functions are deteriorated over time in degenerative rotator cuff tear (dRCT). Therefore, evaluation of the radiological and clinical parameters in cases with dRCT will guide to choose a proper treatment. This article is a case-control study which investigates the effects of age related changes on degree of anatomic abnormalities in individuals with dRCT and the influence of these parameters on upper extremity functions (UEF). 20 healthy participants and 43 symptomatic patients with dRCT participated in this study. The healthy group and patient group were divided into 2 categories based on their ages and degree of abnormalities. UEF was determined with Western Ontario Rotator Cuff Index (WORC) and 9 Hole Peg Test (9PEG). Number of tendons, tear size, humeral head migration>7mm (Mig>7mm), humeral cysts, presence of retraction (PR) and muscle atrophy (MA) were evaluated with MRI. Mean age of the patients with severe radiological parameters was 10 years older than those with mild abnormalities. Mean age of the patients with mild degree abnormalities was cumulated about 50 years whereas those with severe degree abnormalities were around 64 years. Mean age of the patients with Mig>7mm, involvement of more than 2 tendons, PR and MA were significantly older ($p<0.01$). Findings of UEF evaluated by relatively objective method (9PEG) were significantly different from radiological parameters ($p<0.05$), whereas results of UEF evaluated by subjective method (WORC) were not ($p>0.05$). In relatively elderly cases or for the ones with symptomatic dRCT more than 10 years, all radiological components of dRCT are expected to be already in severe degree. Therefore, radiological, objective and subjective assessment modalities should be utilized in examination of the cases with dRCT.

Key Words: Aging, magnetic resonance imaging, outcome measures, rotator cuff tears, upper extremity.

FARKLI YAŞLARDAKI DEJENERATIF ROTATOR MANŞET YIRTIĞI HASTALARINDA RADYOLOJIK BULGULARIN VE ÜST EKSTREMITE FONKSIYONLARININ İNCELENMESI

ÖZET

Dejeneratif rotator manşet yırtığı (dRMY) nda klinik sonuçlar ve üst ekstremite fonksiyonları zamanla kötüleşir. Bu nedenle, dRMY bulunan tüm vakalarda radyolojik ve klinik parametrelerin değerlendirilmesi uygun tedavi seçiminde yol gösterici olacaktır. Bu makale dRMY'li bireylerde yaşa bağlı değişikliklerin anatomik bozuklukların derecesi üzerindeki etkisini ve bu parametrelerin üst ekstremite fonksiyon (ÜEF) ları üzerindeki etkisi inceleyen bir vaka-kontrol çalışmasıdır. Çalışmaya 20 sağlıklı katılımcı ve 43 semptomatik dRMY bulunan hasta katıldı. Sağlıklı grup ve hasta grubu, yaşlarına ve bozukluk derecelerine göre 2 gruba ayrıldı. ÜEF, Western Ontario Rotator Cuff Index'i (WORC) ve 9 Hole Peg Test (9PEG) ile belirlendi. Yırtık tendon sayısı, yırtık büyüklüğü, humerus başı migrasyonu (Mig>7mm), humeral kistler, retraksiyon varlığı (RV) ve kas atrofisi (KA) MRG ile değerlendirildi. İleri seviyede bozuk radyolojik bulguları olan hastaların yaş ortalaması, orta seviyede bozukluk bulunan hastaların yaş ortalamasından yaklaşık 10 yıl daha fazlaydı. Orta seviyede bozukluk olan hastaların yaş ortalaması yaklaşık 50 yıl iken, ileri seviye bozukluk bulunanlarınki ise yaklaşık 64 yıl civarındaydı. 7mm'den büyük migrasyonu olan, iki tendondan fazla yırtık bulunan, retraksiyon ve kas atrofisi tespit edilen hastalar yaşlı grupta idi ($p<0.01$). Kısmen daha objektif yöntem ile (9PEG) değerlendirilen ÜEF bulguları radyolojik parametrelerden anlamlı derecede farklıyken ($p<0.05$), subjektif yöntem ile (WORC) değerlendirilen UEF sonuçları ise farklı değildi ($p>0.05$). Kısmen yaşlı veya semptomatik dRMY bulunan kişilerde 10 yıldan daha uzun sürede tüm radyolojik komponentlerin ileri seviyeye ulaşması beklenir. Bu nedenle, dRMY olan hastaların takibinde radyolojik, objektif ve subjektif değerlendirme modaliteleri kullanılmalıdır.

Anahtar kelimeler: Yaşlanma, manyetik rezonans görüntüleme, sonuç ölçütleri, rotator manşet yırtığı, üst ekstremite

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INTRODUCTION

The degenerative rotator cuff tear (dRCT) is a problem which multiple etiological factors contribute its development. These factors are composed of intrinsic and extrinsic factors. Intrinsic factors include the injuring processes inside the rotator cuff. Among these intrinsic factors (or processes), age related tendon damage along with repetitive minor trauma stands as the main responsible factor for the development of partial thickness tear as well as the progression of partial thickness tear to full tear. Well documented extrinsic ones involve anatomical [1, 2] and other pertinent factors that contribute to either progression of dRCT (such as shoulder overuse, trauma) or the healing process (such as patient's age, diabetes mellitus, smoking).

Age is a comorbid and predisposing factor. Tear prevalence increases as patient population gets older [3, 4]. dRCT was reported as about 13 % of the population in fifth decade, 20 % in sixth decade and 31% in seventh decade [5, 6]. Epidemiological surveys led many authors to conclude that dRCT in elderly asymptomatic patients was an age related condition rather than a specific pathological entity.

dRCT is an insidious condition in which a specific acute incident that attracts the clinical intervention is not present in most of the cases. Clinical outcomes and upper extremity functions are being deteriorated slowly over the time [7]. Therefore, the time span of dRCT has become a subject of interest as well as the age of specific patient. In addition to tear itself, age as an extrinsic factor, is significantly correlated with comorbid conditions of dRCT such as anterior humeral head cyst incidence and size [8], and size of tear [9]. In a study, it was found that as the age increased, the tear size increased, too. However, the effect of age was shown on other anatomical disorders and upper extremity function [10]. The hypothesis of the present study is that both anatomical abnormalities which are aside from tear size and deteriorations of upper extremity function are different in patients from different ages.

The current study investigates 1) the effects of age related changes on degree of anatomic abnormalities in individuals with dRCT and 2) the influence of these parameters on upper extremity functions.

METHODS

This study was approved and performed in accordance with the guidelines of the institutional review board at a state university in Turkey. The current study was based on the patient's files from Orthopedics department for whom surgical treatment of RCT was scheduled. Of all cases, a total of 101 patients whose files were available for the assessment were included in this study. Written consent was taken from all patients to participate in the study beforehand. The rights of human subjects were protected.

Of the 101 patients, 32 were males, 69 were females. Mean age was 51±12.9 years and mean BMI was 28.3+7.6 kg/m2. Fifty-eight patients were excluded from the study (44 were excluded due to traumatic rotator cuff tear, 8 were excluded due to neck pain, and 6 were excluded due to acute rotator cuff tear). For this particular study, the cases with non-traumatic rotator cuff tears were selected. The patients who were physically evaluated by the second author and were found symptomatic (pain, loss of motion, loss of function, weakness) were involved in this study. For each case, diagnosis was

confirmed with MRI. The patients who exhibited any neurological condition, a history of prior shoulder surgery, rheumatoid arthritis, acute rotator cuff tears (less than 3 months), glenohumeral joint osteoarthritis, dislocation, fracture, and adhesive capsulitis were excluded from the investigation.

Radiological assessment was made with magnetic resonance imaging (MRI) in all patients. Number of tendons in tear and the tear sizes were classified according to the system described by Cofield et al [11]. Involvement and retraction of the rotator cuff tendons were assessed with standard, non-contrast coronal, axial and sagittal MRI sequences, as described by Boileau et al [12]. The presence of humeral head migration was evaluated on true anteroposterior shoulder radiographs (positive if acromiohumeral distance < 7 mm) [13]. The fatty degeneration of the rotator cuff musculature was graded on the system described by Goutallier et al [14]. The presence of cystic changes in rotator cuff footprint (major and minor tuberosities) was also recorded based on MRI findings (Figure 1).

For this particular study, patients and age matched controls were grouped as 2 categories based on their ages and the degree of abnormalities. Since all severe anatomical and radiological parameters were exclusively seen in elderly patients (>60 years of age), the data obtained from older patients were compared with those obtained from older controls. Healthy controls who were younger than 60 years of age served as control for patients with mild abnormalities. Healthy controls who were older than 60 years were considered as a control group for the patients with relatively higher grade abnormalities.

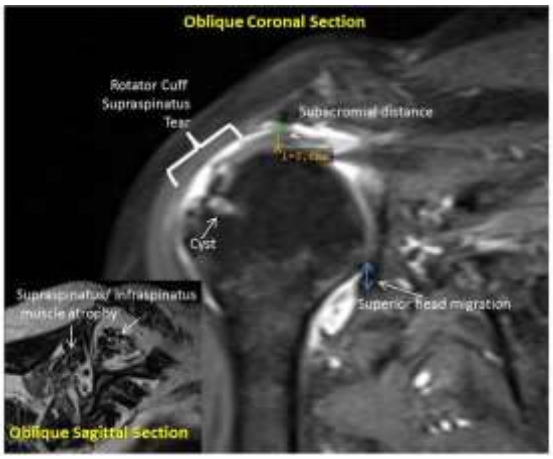

Figure 1: On oblique coronal MRI scan, subchondral cyst, superior migration of humeral head, rotator cuff tear and narrowing of subacromial distance can be seen. On oblique sagittal MRI scan, supraspinatus and infraspinatus muscle athrophy are displayed.

Individuals who did not have problems with their shoulders (totally asymptomatic and did not have history shoulder surgery) and agreed to participate in this study were chosen as controls. Physical examination was performed to rule out the presence of rotator cuff tear in control cases. There were 10 cases in younger and elderly control group (total 20 cases). Demographic features of younger control group are as follows: Mean age is 49.0+8.6 years. Mean BMI is 26.5+5 kg/m2. On the other hand, demographic features of elderly control group are as follows: Mean age 65+4.4 years, BMI is 27.5+4 kg/m2. The sample size of the study was found to be 92% using the G-power program based on the current values of this study.

In all patients, upper extremity function was determined by using Western Ontario Rotator Cuff Index (WORC) and 9 Hole Peg Test (9PEG). WORC was used as the outcome measure to determine the condition-specific functional status and

together a comparative data. The WORC index is a valid and reliable 21-question outcome measurement tool with each question scored 0 to 100 (maximum raw score 2100, then scaled to 100) [9, 15].

In this study, the upper extremity function was objectively determined with 9PEG. 9PEG is a standardized, validated method with normative values in a wide age range that is widely administered to determine the hand and upper extremity function in patients, as well as healthy adults [16 – 19]. It involves picking up nine pegs from the holes one at a time, and placing them in until all nine holes are filled. It is a practical, performance-based clinical tool that is used to evaluate the upper extremity function in different patient groups [7, 16, 20, 21].

Statistical Analysis: Overall summary statistics were assessed for normality, also means and standard deviations or medians were calculated for continuous variables. Frequencies and percentages were calculated for categorical variables. Cyst, retraction and migration were categorized as present or absent tear size was classified as small or large, tear extension was classified as involving 1 or more tendons; finally, atrophy was categorized as normal muscle or advanced fatty changes. An independent t test and a Mann Whitney-U test were used to evaluate the age difference according to the severity of radiological variables. An independent t test was used in other calculations. All tests were evaluated by using 2-sided hypothesis testing with statistical significance α=0.05. Calculations were performed by using PASW version 18 (formerly SPSS Software, Chicago, IL).

RESULTS

Ages and degree of abnormalities of each group are presented in Table 1.

Table 1. Dichotomes in statistical analysis.

	Abnormality	
	Mild	**Severe**
Parameter		
Number of tendons involved*	Less 2	Equal or more than 2
Tear size*	Small	Large
Retraction	Absent	Present
Migration	Absent	Present
Muscle atrophy	Absent	Present
Humeral head cyst	Absent	Present

*Number of involved tendons, tear size, retraction, muscle atrophy and humeral head cyst are classified according to previously published systems (12-15).

Univariate analysis

Patient's group vs Control Group

Mild abnormalities vs Younger cases (<60 years of age)

Severe abnormalities vs Older cases (>60 years of age)

There are forty-three patients with dRCT. Mean age is 59. There are 12 males and 31 females. Of involved cases, 20 are right and 23 are left shoulders. Fifteen patients (35 %) have no additional shoulder pathology except for dRCT; however, 11 patients (26 %), 10 patients (23 %), 5 patients (12 %) have SLAP 2, biceps pathology and acromioclavicular joint degeneration, respectively. Moreover, 2 patients (5 %) have the minimal and non-symptomatic onset of degenerative arthritis.

Distribution of the patient's ages in each anatomic abnormality group is given in Table 2.

The statistical analysis showed that mean age of patients with humeral head migration more than 7 mm, involvement of more than 2 tendons, presence of retraction and muscular atrophy are significantly older patients (p value is less than 0.001 for all four variables). Overall radiological findings in participants who are older than 60 years, were significantly worse than those who are younger than 60. Between mean age of patients with and without

Table 2. Univariate analysis of parameters and patient's ages. (p values that are less than 0.001 are rounded to 0.00)

		Age (year)			
Variables	**(n %)**	**Mean**	**SD**	**Median (min-max)**	**p**
Retraction					
Absent	18 (3.6)	50.43	9.96	49 (27-70)	***0.00***
Present	25 (71.4)	62.72	7.37	63 (49-76)	
Tear tendon					
Single tendon (Only supraspinatus)	32 (74.4)	52.60	10.17	51(27-76)	***0.00***
2-4 tendons	11 (25.6)	64.64	6.82	65 (49-72)	
Tear size					
Small < 2cm	25 (58.14)	50.13	9.33	50 (27-67)	***0.00***
Large ≥ 2cm	18 (41.86)	63.11	7.72	64 (48-76)	
Muscular atrophy					
Normal muscle	14 (32.55)	58.43	8.52	46 (27-70)	***0.03***
Advanced fatty changes	29 (67.44)	64.60	4.04	64 (60-71)	
Humeral head migration					
Acromiohumeral space > 7mm	35 (81.40)	52.94	9.77	52 (27-71)	***0.00***
Acromiohumeral space ≤ 7mm	8 (18.6)	67.75	4.89	67 (62-76)	
Humeral Head Cysts					
Absent	15 (34.88)	54.00	9.70	53 (46-63)	0.05
Present	28 (65.11)	59.3	12.10	62.5 (51-67)	

Values presented as n (%) unless otherwise indicated. Abbreviations: SD,Standard deviation; min-max, minimum-maximum

humeral head cyst is not significantly different (p=0.05). The results showed that mean age of patients with severe radiological parameters is about 10 years older than those with mild degree abnormalities (Table 3). Statistical comparison of the upper extremity function parameters between cases with mild and severe abnormalities are given in Table 4. These scores are significantly low in cases with severe abnormalities in comparison to cases with mild abnormalities (p<0.05). Nevertheless, WORC scores are not significantly different between the groups (p>0.05).

Table 3. Difference of mean ages in parameters.

Variables	**Mild**	**Severe**	**Difference of mean ages (year)**
Retraction	49	63	**14**
Tear tendon	51	65	**14**
Tear size	50	64	**14**
Muscular atrophy	46	64	**18**
Humeral head migration	52	67	**15**
Humeral Head Cysts	53	62	**9**
Median age (year)	**50.5**	**64**	

Table 4. Comparison of upper extremity function parameters betweeen cases with mild and severe abnormalities.

	Mild abnormalities			Severe abnormalities			
	Mean±SD	**Median**	**Range**	**Mean±SD**	**Median**	**Range**	**p**
Number of Tendons in Tear		**Single Tendon**			**2-4 Tendons**		
WORC	39±30	26	9-100	57±39	43	12-100	0.4
9PEG	21±3	20	15-29	22±3	22	17-26	0.4
Tear Size		**Small**			**Large**		
WORC	40±32	27	9-100	46±33	33	12-100	0.7
9PEG	20±3	20	15-28	22±4	22	17-29	**0.04**
Retraction		**Absent**			**Present**		
WORC	45±31	30	9-100	40±35	22	12-100	0.15
9PEG	20±3	19	15-28	22±3	22	17-29	**0.04**
Migration		**Present**			**Absent**		
WORC	43±32	27	9-100	41±37	24	12-100	0.6
9PEG	20±3	19	15-28	24±3	23	20-29	**0.008**
Muscle Atrophy		**Normal**			**Advanced (fatty changes)**		
WORC	38±22	30	15-87	45±37	25	9-100	0.7
9PEG	20±4	19	17-28	22±3	22	15-29	**0.03**
Humeral Head Cysts		**Absent**			**Present**		
WORC	44±33	27	9-100	41±32	26	12-100	0.5
9PEG	21±3	19	15-28	22±3	22	17-29	**0.04**

Abbreviations: SD,Standard deviation; WORC, Western Ontario Rotator Cuff Index; 9PEG, 9 Hole Peg Test.
All units in column seconds for 9PEG and score for WORC.

The comparison of the patients with age matched controls (mild group vs. younger controls and severe abnormalities vs. older healthy controls), shows that in all abnormalities WORC indices are significantly higher in both younger and older patient groups in comparison to age matched control cases ($p<0.05$). In other words, upper extremity function (WORC scores) are significantly reduced (Table 5a, 5b).

When 9PEG scores are compared between control and patient's groups, except for patients with migration, these scores are not significantly different between older control group and patients ($p>0.05$) (table 5a). However, upper extremity function significantly reduces in cases with mild abnormalities in comparison to controls and this is independent of muscle atrophy status ($p<0.05$) (table 5b).

Table 5a. Statistical analysis of upper extremity function parameters among parameters (severe abnormality vs older control group).

Parameter	Severe abnormality patient group Mean ± SD	Control Group Mean ± SD	p
Number of Tendons in Tear (2 or more tendons)			
WORC	57±39	93±5	**0.00**
9PEG	22±3	21±3	**0.56**
Tear Size (large)			
WORC	46±33	93±5	**0.00**
9PEG	22±4	21±3	0.60
Retraction (Present)			
WORC	40±35	93±5	**0.00**
9PEG	22±3	21±3	0.30
Migration (Present)			
WORC	41±37	93±5	**0.00**
9PEG	24±3	21±3	**0.04**
Muscle Atrophy (Present)			
WORC	45±37	93±5	**0.00**
9PEG	22±3	21±3	0.50
Humeral Head Cysts (Present)			
WORC	41±32	93±5	**0.00**
9PEG	22±3	21±3	0.30

Abbreviations: SD,Standard deviation; WORC, Western Ontario Rotator Cuff Index; 9PEG, 9 Hole Peg Test.
All units in column seconds for 9PEG and score for WORC.
(See Table 1 for description of severe abnormality definition in this study. P values that are less than 0.001 are rounded to 0.00)

Table 5b. Statistical analysis of upper extremity function parameters among parameters (mild abnormality vs younger control group).

Parameter	Mild abnormality patient group Mean ± SD	Control Group Mean± SD	p
Number of tendons (less than 2)			
WORC	39±30	96±3	***0.00***
9PEG	21±3	18±2	***0.007***
Tear Size (small)			
WORC	40±32	96±3	***0.00***
9PEG	20±3	18±2	***0.03***
Retraction (absent)			
WORC	45±31	96±3	***0.00***
9PEG	20±3	18±2	***0.04***
Migration (absent)			
WORC	43±32	96±3	***0.00***
9PEG	20±3	18±2	***0.03***
Muscle Atrophy (absent)			
WORC	38±22	96±3	***0.00***
9PEG	20±4	18±2	0.20
Humeral Head Cysts (absent)			
WORC	44±33	96±3	***0.00***
9PEG	21±3	18±2	***0.03***

Abbreviations: SD,Standard deviation; WORC, Western Ontario Rotator Cuff Index; 9PEG, 9 Hole Peg Test.All units in column seconds for 9PEG and score for WORC.
(See Table 1 for description of mild abnormality definition in this study. P values that are less than 0.001 are rounded to 0.00)

Comparison of the upper extremity function parameters between healthy younger and healthy older control group is given in Table 6. WORC index is not significantly different between these groups whereas upper extremity function as measured with 9PEG score is significantly deteriorated in older controls in comparison to younger healthy cases (Table 6).

Table 6. Comparison of upper extremity function indices of younger controls with older controls

Upper Extremity Function	**Older Controls (n=10)**	**Younger Controls (n=10)**	
Parameter	**Mean±SD**	**Mean±SD**	**p**
WORC	96±3	93±6	0.38
9PEG	18±2	21±3	***0.006***

Abbreviations: SD,Standard deviation; WORC, Western Ontario Rotator Cuff Index; 9PEG, 9 Hole Peg Test.
All units in column seconds for 9PEG and score for WORC.

DISCUSSION

The current study showed that mean age of patients with severe radiological parameters was about 10 years older than those with mild degree abnormalities. In PEG tests, UEF difference was statistically significant in all groups. However, subjective assessment results (WORC) were not correlated with radiological parameters.
In older participants, it may be expected that all radiological components of RCT were already in severe degree. However, in individuals with dRCT (who is older than 60), most of the UEF tests (9PEG) did not differ significantly in comparison to both age matched and also younger control groups.

The results of this study also indicated that mean age of patients with mild degree abnormalities were cumulated about 50 years of age. On the other hand, mean age of cases with severe degree abnormalities were around 64. With these observations it might be proposed that a fifty years old patient with mild dRCT may get worse in 10 years or after 65 years of age.

Age as predisposing and contributing factor for dRCT has been assessed in a variety of medical literature [3, 4, 22, 23]. Many studies share the common opinion that being over forty years old is an important risk factor in terms of clinic symptoms in dRCT [2, 8]. In addition to aforementioned time based observation, based on the obtained results, it may be proposed that a dRCT patient in her sixties has severe radiological abnormalities already. Awareness of these age related severity of abnormalities may help personalize treatment options for each individual. Moreover, this information helps adjust the expectation of patients from any form of treatment during initial clinical evaluation.
In the present study, age difference between normal and muscle atrophy group medians is 18 years. Muscular atrophy was evaluated either presence of fatty changes, which is compatible with muscle atrophy, or as "within normal limits which muscle displayed no abnormality in MRI" [24, 25]. As an important contributor to dRCT symptoms, atrophy of muscle also is a determinant of response to treatment and surgical intervention. Meyer et al found that important predictors for repair failure were preoperative fatty muscle infiltration and myotendinous retraction [24]. Similarly; Gladstone et al revealed that fatty infiltration and atrophy of the rotator cuff muscles after rotator cuff repair were correlated with poor functional outcome [25]. Some studies investigated how fatty infiltration and atrophy of the rotator cuff muscles and myotendinous retraction affected the function after repair. Unlike the aforementioned researches, this study displayed the effect of age on fatty infiltration and atrophy of the rotator cuff muscles and myotendinous retraction in patients with dRCT. Association between age and severity of fatty muscle infiltration, muscle atrophy and myotendinous retraction were another subject for investigation, since function of rotator cuff

muscles and success of non-operative treatment could be deteriorated.

In the present study, age of the patients with large tear and involvement of 2 or more tendons were found to be older. Keener et al reported that tear size was the strongest predictor of migration in patients with symptomatic dRCT [26].

Humeral head cyst formation is a result of joint degeneration. Frequency of presence of humeral head cysts are reported to increase as age advances. Suluova et al reported that size of cysts is significantly correlated with advanced age [27]. Other studies supported this observation [21, 28, 29]. The results of this study are similar to previous studies.

Musculotendinous retraction is known as an important pathophysiological consequence of chronic tendon tearing and as a major limitation for successful repair [24, 30]. The results of the present study also indicate that age of the patients in which retraction is present, is significantly older. This observation supports the opinion that tendon tearing is a chronic process which is getting worse as patient age is advanced.

In this study, not all of upper extremity function test results are significantly different between severe and mild patient groups. 9PEG test is an objective assessment based on upper extremity performance whereas WORC is relatively subjective assessment which is self-reported outcome measure. It is believed that the differences among test scores might be derived from methodological variations of these tests.

CONCLUSION

In a patient group with dRCT who is older than 60 years of age, all radiological components of dRCT are most likely in severe degree. The results also showed that radiological findings in participants were expected to be severe degree in elderly group; however, UEF tests might not display abnormal observations. Therefore, it can be concluded that any individual with dRCT, should be evaluated and followed up both with radiological assays and UEF tests.

Limitations

The relatively small sample size constituted by a majority of patients with small-sized dRCT is the major drawback of this study. Chronic dRCT patients were included in the present study; therefore, the obtained results cannot be generalized for all dRCT patients.

Declaration of conflicting interests

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