

# Investigation of C<sub>5</sub>–C<sub>6</sub> radiculopathy and shoulder rotator cuff lesions coexistence frequency

 Cigdem Arifoglu Karaman,<sup>1</sup>  Bengi Oz,<sup>2</sup>  Aylin Sari<sup>1</sup>

<sup>1</sup>Department of Physical Medicine and Rehabilitation, Erenkoy Physical Therapy and Rehabilitation Hospital, Istanbul, Turkey

<sup>2</sup>Department of Physical Medicine and Rehabilitation, Katip Celebi University Atatürk Training and Research Hospital, Izmir, Turkey

## ABSTRACT

**OBJECTIVE:** The aim of this study was to evaluate the coexistence of C<sub>5</sub> and/or C<sub>6</sub> root compression with rotator cuff pathologies and its effect on pain and disability.

**METHODS:** A total of 65 patients with pain radiating from neck to shoulder were retrospectively evaluated on the basis of demographic data, duration of symptoms, overhead activities, and physical examination. The visual numerical scale (VNS), Quick DASH (Disabilities of the Arm, Shoulder, and Hand), and Shoulder Pain and Disability Index (SPADI) were also used. Cervical magnetic resonance imaging (MRI) was used to evaluate C<sub>5</sub>–C<sub>6</sub> root compression, which was separated into two groups as patients with or without upper trunk root compression (UTRC). These groups were compared according to the MRI findings of patients with rotator cuff pathologies.

**RESULTS:** According to our results, C<sub>5</sub> root compression (12.3%), C<sub>6</sub> root compression (41.5%), UTRC (44.6%) were detected. There was no difference between the groups regarding the Hawkins and Neer tests. The Yergason and Jobe tests were statistically higher in patients without UTRC. In the shoulder MRIs, the rate of subscapular muscle tear was significantly higher in patients with UTRC. Other shoulder MRI findings were not different between the groups. VNS-neck and SPADI-pain scores were significantly higher in patients without UTRC. There was no difference between the groups in the scores of VNS-shoulder, Quick DASH, SPADI-disability, and SPADI-total.

**CONCLUSION:** Radiating pain from neck to shoulder that is caused by C<sub>5</sub>–C<sub>6</sub> root compression does not create a predisposition for clinical, radiologic, and functional pathologies in shoulder joint. It seems difficult to diagnose the exact origin of pain in patients who present with neck pain radiating to shoulder based on the findings of cervical or shoulder MRI alone.

*Keywords: Cervical radiculopathy; C<sub>5</sub> root compression; C<sub>6</sub> root compression; impingement syndrome; rotator cuff lesion.*

**Cite this article as:** Arifoglu Karaman C, Oz B, Sari A. Investigation of C<sub>5</sub>–C<sub>6</sub> radiculopathy and shoulder rotator cuff lesions coexistence frequency. *North Clin Istanbul* 2019;6(3):260–266.

One out of every three people in society complains of neck pain due to various reasons at some point in their lives [1]. Shoulder pain is the third most common musculoskeletal pathology [2]. The primary pathology of pain in the shoulder region may not always be related to rotator cuff lesions. Cervical region pathologies can also cause pain complaints on the shoulder and arm [3–5]. Cervical pain, which is among the causes of shoulder pain, is seen at a significant frequency of 5% [6]. When

the frequency of neck-shoulder intersection syndrome was examined, a low degree of concomitancy was found between them [7]. However, it should be kept in mind that the cause of shoulder pain may be related to cervical nerve root irritation [8].

Cervical radiculopathy is a pathological process that progresses with increasing neurophysiological dysfunction of the nerve root. Acute disk herniations that occur in pathological compression conditions affect the



Received: August 16, 2017 Accepted: May 14, 2018 Online: November 16, 2018

Correspondence: Dr. Cigdem ARIFOGLU KARAMAN. Erenkoy Fizik Tedavi ve Rehabilitasyon Hastanesi, Istanbul, Turkey.  
Tel: +90 216 411 80 11 – 1179 e-mail: dr.cigdemarifoglu@gmail.com

© Copyright 2019 by Istanbul Provincial Directorate of Health - Available online at www.northclinist.com

nerve roots, such as degenerative neural foramen stenosis, trauma, and tumor. The pain due to these conditions may spread to the back, anterior chest wall, arm, and forearm. It has been reported that cervical radiculopathy may occur along with arm pain in 99% of patients, sensory changes in 85%, and neck pain in 80% of cases [9]. In C<sub>5</sub>-C<sub>6</sub> radiculopathy, the pain usually radiates to the upper trapezoidal area, the deltoid region, and the lateral portion of the arm [10, 11].

The rotator cuff muscles, which play an important role in the functioning of the shoulder, are innervated with the nerves arising from the C<sub>5</sub> and C<sub>6</sub> nerve roots. Radiculopathy that affects the C<sub>5</sub> and C<sub>6</sub> roots is thought to cause atrophy and weakness in shoulder rotator cuff muscles and deltoid muscle, as well as pain and sensory changes [12]. In particular, it has been argued that C<sub>5</sub> radiculopathy may mimic rotator cuff lesions and that the pain is localized to the shoulder, which may cause weakness of the shoulder during abduction and external rotation [13].

Although there is no randomized or cohort study in the literature on this subject, it is thought that the muscles of the shoulder girdle may be affected in cases where the C<sub>5</sub> and C<sub>6</sub> nerve roots are compressed. There may also be conditions affecting the functionality of the neck and shoulder and the upper extremities. The socio-economic problems caused by neck and shoulder pain in humans are seen very frequently and may cause a significant decrease in their quality of life [14].

In this study, we aimed to investigate the frequency of the C<sub>5</sub> and C<sub>6</sub> spinal roots compression, which is a common etiologic problem in neck-shoulder pain, and rotator cuff lesions coexistence. We also aimed to assess the pain and disability level of affected shoulders in conjunction with clinical and magnetic resonance imaging (MRI) findings.

## MATERIALS AND METHODS

Patients aged 18–70 years who applied to our outpatient clinic from December 2014 to April 2015 with the complaint of pain radiating from the neck to shoulder and had cervical and shoulder MRI examinations were included in our study. Patients with a history of pregnancy, chronic alcoholism, myocardial infarction within the past 6 months, diabetes mellitus, malignancy, cervical surgery, shoulder trauma, and vascular, inflammatory, infectious or neurological diseases were excluded from the study.

The study protocol was approved by the İzmir Kâtip

Çelebi University Atatürk Training and Research Hospital Ethics Committee. Cervical MRI examinations of the patients were evaluated for the presence of C<sub>5</sub> and C<sub>6</sub> root compression. According to the presence of compression on the C<sub>5</sub> and/or C<sub>6</sub> root(s), a total of 65 patients were divided into two groups: with and without upper truncus root compression (UTRC). Age, gender, occupation, working status requiring overhead activities, and duration of neck and shoulder pain were recorded.

The positivity of the following tests was recorded: scapular winging, atrophy of shoulder muscles, limited range of motion (ROM) of the shoulder, impingement tests (Hawkins, Neer, and painful arc test), the Speed and Yergason tests for biceps pathology, the Jobe, drop arm test, external rotation resistance, trumpet sign, lift-off, and abdominal compression tests for rotator cuff muscle strength. ROM of the shoulder joint was considered to be normal if the angles of flexion and abduction were 180° and the internal rotation (IR) and external rotation (ER) angles were 90°. The lower values were recorded as “decreased” ROM.

The positivity of the Hawkins and/or Neer test was recorded as “impingement tests positive”, and if both of them were negative, it was recorded as “impingement tests negative”. A diagnosis of clinical impingement was made based on these tests.

The neurological examination consisted of evaluating motor and sensory examinations, deep tendon reflexes (DTR), and pathological reflexes. During the motor examination, those with myotomal muscle strength of 5/5 were grouped as “normal” and the lower values were recorded as “decreased myotomal strength”.

In the sensory examination, the superficial and pain sensations were evaluated and grouped as “normal” and “diminished. Deep tendon reflexes (DTRs) were grouped as “normal” and “decreased”. Pathological reflexes were evaluated by the Babinski and Hoffman tests. The visual numerical scale (VNS) is a simple method that can be used to assess the severity of subjective pain. This test is easy to understand by both the patient and the practitioner, and positively correlates with other measurement methods [15]. In our study, VNS measurements for neck and shoulder pain in the patient records were evaluated using scores between 0 and 10.

The shortened forms of disabilities of arm, shoulder, and hand (Quick DASH) questionnaire is frequently used to evaluate the physical functions and symptoms of upper extremity. It is an abridged version of the 30-ques-

tion DASH questionnaire and can be effectively used instead of DASH [16–18]. In this study, the results of the Quick DASH questionnaire were evaluated, which were included in the patients' medical records and had scores between 0–100.

The Shoulder Pain and Disability Index (SPADI) is used to measure the level of pain and disability associated with shoulder pathologies and to assess shoulder functionality. It consists of a total of two sections and 13 questions, 5 of which assess pain and 8 of which assess disability. The total SPADI score is calculated by averaging the scores of two sections. The total score can be between 0 and 100, and a higher score indicates a worsened disability. In the present study, the Turkish version of the SPADI, which has been proven to be valid and reliable, was used [19].

Previous medical records were used in the evaluation of the cervical and shoulder MRI examinations of the patients included in our study. These records had been reported by a radiologist and loaded in the computer database of our hospital. Foraminal constriction and root compression at  $C_4$ – $C_5$  and  $C_5$ – $C_6$  vertebral levels were evaluated on the cervical MRI. Patients were classified according to the presence of upper trunk nerve root compression (UTRC) if there was  $C_5$  and/or  $C_6$  root compression. MRIs of the shoulders where the neck pain had radiated were evaluated.

The stages of impingement detected on the shoulder MRI, rupture and atrophy of the supraspinatus, infraspinatus and subscapularis muscles, pathologies of the biceps muscle (tendinitis, tendinosis, rupture), acromioclavicular joint (ACE) hypertrophy, signs of adhesive capsulitis, changes in humeral head, and labrum rupture were recorded. Impingement (subacromial impingement) syndrome was evaluated in four stages as recommended by Zlatkin et al. [20] and the other findings were recorded as “present” or “absent”.

### Statistical Analysis

The SPSS for Windows 16.0 statistical package program was used to evaluate the data. The demographic data of the patients were evaluated by descriptive analysis. Evaluations from Pearson's Chi-square or Fisher's Exact test were used to compare categorical variables between the groups. The Mann-Whitney U test was used to compare continuous variables between groups because the data did not show normal distribution. The level of statistical significance was considered at  $p < 0.05$ .

## RESULTS

A total of 54 (83.1%) female and 11 (16.9%) male patients with a mean age of  $46.23 \pm 9.33$  years who presented with complaints of neck-to-shoulder pain were included in the study. When the cervical MRI examinations of the patients were examined, no cervical pathology was detected in 4.6% of the patients, while the remaining patients had cervical pathologies such as spondylosis, disc hernia, and narrow canals. Eight (12.3%) patients had  $C_5$  root compression and 27 (41.5%) had  $C_6$  root compression. Upper trunk root compression ( $C_5$  and/or  $C_6$ ) was detected in only 29 (44.6%) patients, while in 36 (55.4%) UTRC wasn't detected. In 20.7% ( $n=6$ ) of the patients with UTRC,  $C_5$  and  $C_6$  root compression were observed simultaneously. The mean age of patients with UTRC was statistically significantly higher than those without UTRC ( $p=0,011$ ).

No statistically significant difference was found between the two groups in terms of sex, neck and shoulder pain duration, overhead activity, and paresthesia ( $p > 0.05$ ). The VNS-neck pain scores were higher in patients without UTRC and there was a statistically significant difference between the two groups ( $p=0.048$ ). However, no statistically significant difference was found between the groups in terms of VNS-shoulder pain scores ( $p > 0.05$ ). Rate of patients with clinical impingement syndrome was 86.2% in with-UTRC group and 91.7% in without-UTRC group. No significant intergroup difference was detected ( $p > 0.05$ ) (Table 1) in this case.

When the physical examination findings of the patients' shoulders were compared (Table 1), the Yergason test scores were found to be higher in patients without UTRC ( $p=0.041$ ). The Neer, Hawkins and Speed tests did not show any statistically significant difference between the groups ( $p > 0.05$ ). The Jobe test evaluated the continuity and muscle strength of the rotator cuff muscles to be highly positive in non-UTRC patients, and this intergroup difference was statistically significant ( $p=0.025$ ). There was no statistically significant difference between the groups in terms of painful arc, drop arm, ER resistance, lift-off, abdominal compression tests, and trumpet sign ( $p > 0.05$ ).

Among these tests, the drop arm test and trumpet sign were not positive in any of the patients in the UTRC group. There was no statistically significant difference in the ROM of the shoulder between patients with and without UTRC ( $p > 0.05$ ) (Table 1).

There was no significant difference between the

**TABLE 1.** Comparison of the patient groups as for demographic data, pain, and physical examination findings

n=65	UTRC (+) (n=29)		UTRC (-) (n=36)		p
	n	%	n	%	
Age (years)	49.86±8.06		43.30±9.36		<b>0.011*</b>
Gender					
Female	22	75.9	32	88.9	0.196 <sup>†</sup>
Male	7	24.1	4	11.1	
Duration of neck pain (months)	34.82±35.47		31.33±33.80		0.497*
Duration of shoulder pain (months)	28.03±36.08		14.15±18.83		0.057*
Overhead activity					
+	17	58.6	18	50	0.488 <sup>‡</sup>
-	12	41.4	18	50.0	
VNS-neck (0-10)	6.58±2.16		7.63±2.11		<b>0.048*</b>
VNS-shoulder (0-10)	7.44±2.24		8.19±2.31		0.083*
Paresthesia					
+	17	58.6	26	72.2	0.249 <sup>‡</sup>
-	12	41.4	10	27.8	
Clinical impingement					
+	25	86.2	33	91.7	0.691 <sup>†</sup>
-	4	13.8	3	8.3	
Hawkins test					
+	21	72.4	33	91.7	0.051 <sup>†</sup>
-	8	27.6	3	8.3	
Neer test					
+	20	69.0	25	69.4	0.967 <sup>‡</sup>
-	9	31.0	11	30.6	
Speed test					
+	19	65.5	31	86.1	0.050 <sup>‡</sup>
-	10	34.5	5	13.9	
Yergason test					
+	12	41.4	24	66.7	<b>0.041*</b>
-	17	58.6	12	33.3	
Painful arc test					
+	16	55.2	27	75.0	0.093 <sup>‡</sup>
-	13	44.8	9	25.0	
Jobe test					
+	18	62.1	31	86.1	<b>0.025*</b>
-	11	37.9	5	13.9	
Drop arm test and trumpet sign					
+	0	0	2	5.6	0.498 <sup>†</sup>
-	29	100	34	94.4	
ER resistance test					
+	16	55.2	26	72.2	0.153 <sup>‡</sup>
-	13	44.8	10	27.8	
Lift-off test					
+	11	37.9	18	50	0.331 <sup>‡</sup>
-	18	62.1	18	50.0	
Abdominal compression test					
+	1	3.4	3	8.3	0.622 <sup>†</sup>
-	28	96.6	33	91.7	
Superficial sensation					
N	23	79.3	28	77.8	0.881 <sup>‡</sup>
Decreased	6	20.7	8	22.2	
Pain sensation					
N	26	89.7	30	83.3	0.720 <sup>†</sup>
Decreased	3	10.3	6	16.7	
C <sub>5</sub> muscle strength					
N	29	100	35	97.2	1.00 <sup>†</sup>
Decreased	0	0	1	2.8	
Shoulder flexion, and abduction, and ER					
N	29	100	32	88.9	0.122
Decreased	0	0	4	11.1	
Shoulder IR					
N	29	100	33	91.7	0.247
Decreased	0	0	3	8.3	

<sup>†</sup>Fisher's Exact test; \*Mann-Whitney U test; <sup>‡</sup>Pearson chi-square test; UTRC: Upper trunk root compression; VNS: Visual numerical scale; ER: External rotation; N: Normal; IR: Internal Rotation.

**TABLE 2.** Comparison of the radiological findings of the patient groups

n=65	UTRC (+)		UTRC (-)		p
	(n=29)		(n=36)		
	n	%	n	%	
Impingement					
Stage 0	2	6.9	2	5.6	0.961
Stage 1	7	24.1	10	27.8	
Stage 2	16	55.2	18	50.0	
Stage 3	4	13.8	6	16.7	
m.supraspinatus tear					
+	15	51.7	23	63.9	0.323 <sup>‡</sup>
-	14	48.3	13	36.1	
m.infraspinatus tear					
+	12	41.4	9	25.0	0.160 <sup>‡</sup>
-	17	58.6	27	75.0	
m.subscapularis tear					
+	12	41.4	5	13.9	<b>0.012<sup>‡</sup></b>
-	17	58.6	31	86.1	
Biceps pathology					
+	11	37.9	16	44.4	0.596 <sup>‡</sup>
-	18	62.1	20	55.6	
Adhesive capsulitis					
+	5	17.2	5	13.9	0.742 <sup>†</sup>
-	24	82.8	31	86.1	
Changes in humeral bone					
+	16	55.2	15	41.7	0.279 <sup>‡</sup>
-	13	44.8	21	58.3	
Labrum pathology					
+	7	24.1	7	19.4	0.647 <sup>‡</sup>
-	22	75.9	29	80.6	
Atrophy of m.supraspinatus					
+	11	37.9	14	38.9	0.937 <sup>‡</sup>
-	18	62.1	22	61.1	
Atrophy of m.infraspinatus					
+	11	37.9	11	30.6	0.532 <sup>‡</sup>
-	18	62.1	25	69.4	
Atrophy of m.subscapularis					
+	10	34.5	9	25.0	0.403 <sup>‡</sup>
-	19	65.5	27	75.0	
Bursitis					
+	5	17.2	10	27.8	0.316 <sup>‡</sup>
-	24	82.8	26	72.2	

<sup>†</sup>Fisher's Exact test; <sup>‡</sup>Pearson Chi-square test; UTRC: Upper trunk root compression.

groups in terms of the superficial sensory and pain examinations and the motor examination tests of the elbow flexor muscles (m.biceps and m.brachialis) performed for the evaluation of the C<sub>5</sub> spinal nerve ( $p > 0.05$ ) (Table 1). In the motor examination of the wrist extensor muscles (m.extensor carpi radialis longus and brevis), the DTRs were not pathologic in any patient. Therefore, these parameters were excluded from the evaluation.

There was no statistically significant difference between patients in terms of impingement staging according to the shoulder MRI ( $p > 0.05$ ) (Table 2). Stage 2 im-

**TABLE 3.** Comparison of shoulder pain and disability scales of the patient groups

n=65	UTRC (+)		UTRC (-)		p
	(n=29)		(n=36)		
	n	%	n	%	
Quick DASH	49.53	±15.70	56.35	±20.0	0.124
SPADI (pain) (%)	70.27	±22.02	80.27	±17.76	<b>0.033</b>
SPADI (disability) (%)	47.97	±22.51	59.06	±27.83	0.092
SPADI (total) (%)	59.12	±20.23	69.66	±21.63	0.057

\*Mann-Whitney U test; UTRC: Upper trunk root compression; Quick DASH: Shortened form of disabilities of arm, shoulder, and hand, SPADI: Shoulder Pain and Disability Index.

pingement syndrome was the most common radiological finding in both groups. Shoulder MRI examinations revealed supraspinatus ( $n=38; 58.5\%$ ), infraspinatus ( $n=21; 32.3\%$ ), subscapularis ( $n=17; 26.2\%$ ) muscle ruptures and bicipital pathologies ( $n=27; 41.5\%$ ) in the respective number of patients. Supraspinatus ( $n=25; 38.5\%$ ), infraspinatus ( $n=33.8\%$ ) ( $n=22$ ), and subscapularis ( $n=19; 29.2\%$ ) muscle atrophies were detected in the respective number of patients. Subscapularis muscle rupture was found to be statistically higher in patients with UTRC ( $p=0.012$ ).

No statistically significant difference was found between the groups in terms of rupture of supraspinatus and infraspinatus muscles, atrophy of the supraspinatus, infraspinatus and subscapularis muscles, pathologies of the biceps, findings of adhesive capsulitis, bony changes in the humeral head, and labrum and bursa pathologies ( $p > 0.05$ ) (Table 2).

Quick DASH and SPADI questionnaires evaluating shoulder pain and disability were compared between the groups. SPADI-pain scores were relatively higher in the non-UTRC group ( $p=0.033$ ). There was no significant difference between the groups in terms of Quick DASH, SPADI-disability, and SPADI-total scores ( $p > 0.05$ ) (Table 3).

## DISCUSSION

It is well known that cervical pathologies can cause neck pain as well as shoulder and arm pain. In cervical radiculopathy, which is one of the most important causes of neck-to-shoulder pain, the involvement of the C<sub>6</sub> root is most commonly observed, followed by involvement of both C<sub>5</sub> and C<sub>6</sub> roots, and then only the C<sub>5</sub> root [21, 22]. The involvement of C<sub>5</sub> and C<sub>6</sub> roots is also significant for shoulder girdle muscles.

In the brachial plexus, the suprascapular nerve originating from the upper trunk (formed by the combination of C<sub>5</sub> and C<sub>6</sub> roots) innervates the supraspinatus and infraspinatus muscles. In addition, the subscapular nerve arising from the posterior fasciculus (formed by the posterior branch of the upper trunk) innervates the subscapular muscle. The axillary nerve innervates the deltoid and teres minor muscles. Therefore, this study was planned considering that the innervation of the rotator cuff muscles may be impaired, and as a result, rotator cuff activity and shoulder joint function may be affected if the C<sub>5</sub> and C<sub>6</sub> nerve roots are compressed.

In our study, we evaluated the relationship between C<sub>5</sub> and C<sub>6</sub> radiculopathy and shoulder lesions by clinical and MRI findings. We detected that upper trunk root compression may constitute a risk for only subscapularis muscle rupture, but otherwise does not predispose to any clinical, radiological, and functional pathology in shoulder.

When the literature is examined, the number of studies involving both shoulder and cervical region pathologies is quite limited. In the few studies that have been performed, additional pathologies, such as cervical radiculopathy, were investigated with different tests (mainly EMG) in the patients with shoulder pathology. MRI findings for cervical radiculopathy have not been evaluated in the previous studies; our study is unique because all of our patients were examined with MRI findings in addition to clinical findings.

In a study in which 191 patients with suspected cervical radiculopathy were evaluated for myofascial pain, impingement syndrome, lateral epicondylitis, and deQuervain tenosynovitis; cervical radiculopathy was seen in 9% of the patients with shoulder impingement syndrome. In the same study, impingement syndrome was found to be significantly less frequent in the group with cervical radiculopathy [23]. Vad et al. [24] detected neurological findings in 28% of EMG examinations of 25 patients with full-thickness rotator cuff tears and severe atrophy of the shoulder muscles. C<sub>6</sub> radiculopathy was detected in 14.2% of the patients, upper truncus or axillary neuropathy in 57.1%, and suprascapular neuropathies were found in 28.5% of the patients [24].

In another study, cervical radiculopathy was shown in only one of 26 patients with rotator cuff tears [25]. In a study of 33 patients diagnosed with shoulder impingement syndrome, confirmed C<sub>5</sub>-C<sub>6</sub> radiculopathy was detected in 5.3% of patients and possible cervical radiculopathy was seen in 23.7% of the patients. It was recom-

mended that cervical radiculopathy be kept in mind as a possible source of pain in the evaluation of patients with shoulder pain [26]. When all these studies are evaluated, it should be considered that those nerve injuries that cause shoulder pathologies can occur not only at the root level but also at other levels of the brachial plexus.

The incidence of cervical radiculopathy increases with age. It has the highest incidence rates between the ages of 50-54 years, and its frequency decreases over the age of 60 years [21]. In the literature, cervical radiculopathy has been shown to be more common in men [9, 21, 27, 28]. In our study, the majority of patients presenting with neck-to-shoulder pain were female, and the mean age of pain occurrence ( $49.86 \pm 8.06$  years) was statistically higher in patients with C<sub>5</sub>-C<sub>6</sub> root compression.

In the Quick DASH and SPADI questionnaires, we evaluated the reflection of the clinical and radiological data on pain and disability. The SPADI-pain scores were significantly higher in the non-C<sub>5</sub>-C<sub>6</sub> root compression group, while no statistically significant intergroup difference was detected for the Quick DASH and SPADI-disability and SPADI-total scores.

The VNS-neck values were lower in patients with C<sub>5</sub>-C<sub>6</sub> root compression than in those without. In the literature, we did not find any other study that used the VNS, Quick DASH, and SPADI questionnaires in the presence of C<sub>5</sub>-C<sub>6</sub> root compression. The higher VNS-neck value in patients without the compression may be due to the fact that C<sub>5</sub>-C<sub>6</sub> root compression is not the only cause of neck pain and other pathologies may have caused neck pain in our patients. In patients without C<sub>5</sub>-C<sub>6</sub> root compression, higher SPADI-pain scores could be associated with isolated shoulder pathology or involvement of more distal levels of the brachial plexus.

The most important limitations of our study were, firstly, the limited number of patients available for enrollment, and secondly, the radicular involvement that occurred because of root compression could not be supported by EMG findings. These limitations may cause the result that compression of the upper trunk root only poses a risk for subscapularis muscle rupture but otherwise does not predispose to a clinical, radiological, or functional pathology in the shoulder. Therefore, in our daily practice, for patients with neck and shoulder pain, it may be a more accurate approach to evaluate the patient with a cervical MRI when making differential diagnosis of radicular pain and then confirm it with an EMG if necessary.

However, as in previous studies, only EMG-mediated diagnoses may not be sufficient for optimal evaluation. Prospective studies with long-term follow-ups and sample sizes comprising larger populations are needed.

In conclusion, neck pain radiating to the shoulder may be associated with cervical radiculopathy. It should be kept in mind that the underlying cervical pathology may affect the rotator cuff muscles and that the primary pathology may be caused by factors that do not involve the rotator cuff in patients presenting with shoulder pain.

Due to the socio-economic problems and poor quality of life caused by neck and shoulder pain, it is important to determine the main source of pain and arrange treatment accordingly.

**Ethics Committee Approval:** The study protocol was approved by the Izmir Katip Celebi University, Atatürk Training and Research Hospital Ethics Committee (11.12.2014/255).

**Conflict of Interest:** No conflict of interest was declared by the authors.

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

**Authorship Contributions:** Concept – BO; Design – BO, CAK; Supervision – BO; Materials – CAK; Data collection and/or processing – CAK; Analysis and/or interpretation – BO, CAK; Writing – CAK; Critical review – BO, AS.

## REFERENCES

- Zhuang L. Twenty one cases of vertebral-artery-type cervical spondylosis treated with acupuncture and moxibustion. *J Tradit Chin Med* 2000;20:280–1.
- Urwin M, Symmons D, Allison T, Brammah T, Busby H, Roxby M, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis* 1998;57:649–55.
- De Palma AF. *Surgery of the Shoulder*. 3<sup>rd</sup> ed. Philadelphia: Lippincott Williams&Wilkins; 1983. p. 571–80.
- Hawkins RJ. Cervical spine and the shoulder. *Instr Course Lect* 1985;34:191–5.
- Bateman JE. Neurologic painful conditions affecting the shoulder. *Clin Orthop Relat Res* 1983;44–54.
- Sarpel T. Omuz Ağrısı Nedenleri ve Muayenesi. In: Beyazova M, Gökçe Kutsal Y, editors. *Fiziksel Tıp ve Rehabilitasyon*. 2<sup>nd</sup> ed. Ankara: Güneş Tıp Kitabevleri; 2011. p. 1995–2018.
- Sembrano JN, Yson SC, Kanu OC, Braman JP, Santos ER, Harrison AK, et al. Neck-shoulder crossover: how often do neck and shoulder pathology masquerade as each other? *Am J Orthop (Belle Mead NJ)* 2013;42:E76–80.
- Coventry MB. Problem of painful shoulder. *J Am Med Assoc* 1953;151:177–85.
- Henderson CM, Hennessy RG, Shuey HM Jr, Shackelford EG. Posterior-lateral foraminotomy as an exclusive operative technique for cervical radiculopathy: a review of 846 consecutively operated cases. *Neurosurgery* 1983;13:504–12.
- Ellenberg MR, Honet JC, Treanor WJ. Cervical radiculopathy. *Arch Phys Med Rehabil* 1994;75:342–52.
- Slipman CW, Plastaras CT, Palmitier RA, Huston CW, Sterenfeld EB. Symptom provocation of fluoroscopically guided cervical nerve root stimulation. Are dynamical maps identical to dermatomal maps? *Spine (Phila Pa 1976)* 1998;23:2235–42.
- Manifold SG, McCann PD. Cervical radiculitis and shoulder disorders. *Clin Orthop Relat Res* 1999;105–13.
- Carette S, Fehlings MG. Clinical practice. Cervical radiculopathy. *N Engl J Med* 2005;353:392–9.
- Lundberg G, Gerdle B. Tender point scores and their relations to signs of mobility, symptoms, and disability in female home care personnel and the prevalence of fibromyalgia syndrome. *J Rheumatol* 2002;29:603–13.
- Erdine S. Ağrının derecelendirilmesi ve ağrı ölçümleri. In: Erdine S, editor. *Ağrı*. 1<sup>st</sup> ed. İstanbul: Nobel Tıp Kitabevleri; 2000. p. 98–100.
- Beaton DE, Wright JG, Katz JN; Upper Extremity Collaborative Group. Development of the QuickDASH: comparison of three item-reduction approaches. *J Bone Joint Surg Am* 2005;87:1038–46.
- Gummeson C, Ward MM, Atroshi I. The shortened disabilities of the arm, shoulder and hand questionnaire (QuickDASH): validity and reliability based on responses within the full-length DASH. *BMC Musculoskelet Disord* 2006;7:44.
- The Quick DASH Türkçe. Available at: [http://www.dash.iwh.on.ca/sites/dash/public/translations/QuickDASH\\_Turkish\\_2012.pdf](http://www.dash.iwh.on.ca/sites/dash/public/translations/QuickDASH_Turkish_2012.pdf). Accessed 2006.
- Bumin G, Tuzun EH, Tonga E. The Shoulder Pain and Disability Index (SPADI): cross-cultural adaptation, reliability, and validity of the Turkish version. *J Back Musculoskelet Rehabil* 2008;21:57–62.
- Zlatkin MB, Iannotti JP, Roberts MC, Esterhai JL, Dalinka MK, Kressel HY, et al. Rotator cuff tears: diagnostic performance of MR imaging. *Radiology* 1989;172:223–9.
- Radhakrishnan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy. A population-based study from Rochester, Minnesota, 1976 through 1990. *Brain* 1994;117:325–35.
- Lunsford LD, Bissonette DJ, Jannetta PJ, Sheptak PE, Zorub DS. Anterior surgery for cervical disc disease. Part 1: Treatment of lateral cervical disc herniation in 253 cases. *J Neurosurg* 1980;53:1–11.
- Cannon DE, Dillingham TR, Miao H, Andary MT, Pezzin LE. Musculoskeletal disorders in referrals for suspected cervical radiculopathy. *Arch Phys Med Rehabil* 2007;88:1256–9.
- Vad VB, Southern D, Warren RE, Altchek DW, Dines D. Prevalence of peripheral neurologic injuries in rotator cuff tears with atrophy. *J Shoulder Elbow Surg* 2003;12:333–6.
- Costouros JG, Porramatikul M, Lie DT, Warner JJ. Reversal of suprascapular neuropathy following arthroscopic repair of massive supraspinatus and infraspinatus rotator cuff tears. *Arthroscopy* 2007;23:1152–61.
- Date ES, Gray LA. Electrodiagnostic evidence for cervical radiculopathy and suprascapular neuropathy in shoulder pain. *Electromyogr Clin Neurophysiol* 1996;36:333–9.
- Yoss RE, Corbin KB, MacCarthy CS, Love JG. Significance of symptoms and signs in localization of involved root in cervical disk protrusion. *Neurology* 1957;7:673–83.
- Kelsey JL, Githens PB, Walter SD, Southwick WO, Weil U, Holford TR, et al. An epidemiological study of acute prolapsed cervical intervertebral disc. *J Bone Joint Surg Am* 1984;66:907–14.