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Investigation of C_5–C_6 radiculopathy and shoulder rotator cuff lesions coexistence frequency

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ABSTRACT

OBJECTIVE: The aim of this study was to evaluate the coexistence of C_5 and/or C_6 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_5–C_6 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_5 root compression (12.3%), C_6 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_5–C_6 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_5 root compression; C_6 root compression; impingement syndrome; rotator cuff lesion.

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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

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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_5–C_6 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_5 and C_6 nerve roots. Radiculopathy that affects the C_5 and C_6 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_5 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_5 and C_6 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_5 and C_6 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_5 and C_6 root compression. According to the presence of compression on the C_5 and/or C_6 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) anges 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±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 Yergeason 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		**0.011***
Gender					
Female	22	75.9	32	88.9	
Male	7	24.1	4	11.1	0.196†
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	
–	12	41.4	18	50.0	0.488‡
VNS-neck (0–10)	6.58±2.16		7.63±2.11		**0.048***
VNS-shoulder (0–10)	7.44±2.24		8.19±2.31		0.083*
Paresthesia					
+	17	58.6	26	72.2	
–	12	41.4	10	27.8	0.249‡
Clinical impingement					
+	25	86.2	33	91.7	
–	4	13.8	3	8.3	0.691†
Hawkins test					
+	21	72.4	33	91.7	
–	8	27.6	3	8.3	0.051†
Neer test					
+	20	69.0	25	69.4	
–	9	31.0	11	30.6	0.967‡
Speed test					
+	19	65.5	31	86.1	
–	10	34.5	5	13.9	0.050‡
Yergason test					
+	12	41.4	24	66.7	
–	17	58.6	12	33.3	**0.041**‡
Painful arc test					
+	16	55.2	27	75.0	
–	13	44.8	9	25.0	0.093‡
Jobe test					
+	18	62.1	31	86.1	
–	11	37.9	5	13.9	**0.025**‡
Drop arm test and trumpet sign					
+	0	0	2	5.6	
–	29	100	34	94.4	0.498†
ER resistance test					
+	16	55.2	26	72.2	
–	13	44.8	10	27.8	0.153‡
Lift- off test					
+	11	37.9	18	50	
–	18	62.1	18	50.0	0.331‡
Abdominal compression test					
+	1	3.4	3	8.3	
–	28	96.6	33	91.7	0.622†
Superficial sensation					
N	23	79.3	28	77.8	
Decreased	6	20.7	8	22.2	0.881‡
Pain sensation					
N	26	89.7	30	83.3	
Decreased	3	10.3	6	16.7	0.720†
C_5 muscle strength					
N	29	100	35	97.2	
Decreased	0	0	1	2.8	1.00†
Shoulder flexion, and abduction, and ER					
N	29	100	32	88.9	
Decreased	0	0	4	11.1	0.122
Shoulder IR					
N	29	100	33	91.7	
Decreased	0	0	3	8.3	0.247

†Fisher's Exact test; *Mann-Whitney U test; ‡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 (+) (n=29)		UTRC (-) (n=36)		p
	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‡
–	14	48.3	13	36.1	
m.infraspinatus tear					
+	12	41.4	9	25.0	0.160‡
–	17	58.6	27	75.0	
m.subscapularis tear					
+	12	41.4	5	13.9	**0.012**‡
–	17	58.6	31	86.1	
Biceps pathology					
+	11	37.9	16	44.4	0.596‡
–	18	62.1	20	55.6	
Adhesive capsulitis					
+	5	17.2	5	13.9	0.742†
–	24	82.8	31	86.1	
Changes in humeral bone					
+	16	55.2	15	41.7	0.279‡
–	13	44.8	21	58.3	
Labrum pathology					
+	7	24.1	7	19.4	0.647‡
–	22	75.9	29	80.6	
Atrophy of m.supraspinatus					
+	11	37.9	14	38.9	0.937‡
–	18	62.1	22	61.1	
Atrophy of m.infraspinatus					
+	11	37.9	11	30.6	0.532‡
–	18	62.1	25	69.4	
Atrophy of m.subscapularis					
+	10	34.5	9	25.0	0.403‡
–	19	65.5	27	75.0	
Bursitis					
+	5	17.2	10	27.8	0.316‡
–	24	82.8	26	72.2	

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

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

n=65	UTRC (+) (n=29)	UTRC (-) (n=36)	p
Quick DASH	49.53±15.70	56.35±20.0	0.124
SPADI (pain) (%)	70.27±22.02	80.27±17.76	**0.033**
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.

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_5 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 impingement 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_6 root is most commonly observed, followed by involvement of both C_5 and C_6 roots, and then only the C_5 root [21, 22]. The involvement of C_5 and C_6 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_5 and C_6 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_5 and C_6 nerve roots are compressed.

In our study, we evaluated the relationship between C_5 and C_6 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_6 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_5–C_6 radiculopathy was detected in 5.3% of patients and possible cervical radiculopathy was seen in 23.7% of the patients. It was recommended 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 occurence (49.86±8.06 years) was statistically higher in patients with C_5–C_6 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_5–C_6 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_5–C_6 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_5–C_6 root compression The higher VNS-neck value in patients without the compression may be due to the fact that C_5–C_6 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_5–C_6 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, Ataturk Training and Research Hospital Ethics Committee (11.12.2014/255).

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