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**Türk Fizyoterapi ve Rehabilitasyon Dergisi**

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# THE EFFECTS OF ADDITIONAL PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION OVER CONVENTIONAL THERAPY IN PATIENTS WITH ADHESIVE CAPSULITIS

**RESEARCH ARTICLE**

**ABSTRACT**

**Purpose:** This study is performed to investigate the effectiveness of upper extremity and scapula Proprioceptive Neuromuscular Facilitation (PNF) techniques in adhesive capsulitis (AC).

**Methods:** Thirty-six subjects were randomized into two groups. Control group (n=18) was treated with conventional physiotherapy applications consisting of hot-pack and ultrasound, and wall and wand exercises instructed as a home program; study group (n=18) was treated with upper extremity and scapula PNF patterns besides conventional physiotherapy. Patients were treated five times a week, for a total of 15 sessions. Pain intensity was assessed on a visual analogue scale; postural deformities were evaluated by inspection. Range of shoulder movements (ROM) were measured by a universal goniometer. "Lateral Scapular Slide Test" and assessment of scapular position were used for evaluation of the scapula. Functional performance was assessed by Shoulder Pain and Disability Index (SPADI).

**Results:** Intensity of pain during activity significantly decreased and ROM increased in both groups ($p<0.05$). While increase amounts of shoulder flexion and abduction ROMs were higher in the PNF group ($p<0.05$), there was no difference between groups in internal and external rotation movements. Although, night pain significantly decreased in the study group ($p<0.05$), it remained unchanged in the control group ($p>0.05$). Scapula position didn't change after therapy in both groups ($p>0.05$). SPADI scores decreased in both groups ($p<0.05$).

**Discussion:** This study showed that PNF patterns provide significant contribution to night pain and range of flexion and abduction movements in patients with AC. Including PNF applications in AC treatment program may provide better outcomes.

**Keywords:** Adhesive Capsulitis; Frozen Shoulder; Scapula; Proprioceptive Neuromuscular Facilitation (PNF); SPADI (Shoulder Pain and Disability Index).

# ADEZİV KAPSÜLİTLİ HASTALARDA GELENEKSEL TEDAVİYE EK OLARAK PROPRİOSEPTİF NÖROMÜSKÜLER FASİLİTASYONUN ETKİLERİ

**ARAŞTIRMA MAKALESİ**

**ÖZ**

**Amaç:** Bu çalışma adeziv kapsülitli hastalarda, üst ekstremite ve skapula Proprioseptif Nöromusküler Fasilitasyon (PNF) tekniklerinin tedavi etkinliğinin incelenmesi amacıyla gerçekleştirilmiştir.

**Yöntemler:** Çalışmaya katılan 36 olgu, rastgele iki gruba ayrılmıştır. Kontrol grubundaki hastalar (n=18) geleneksel fizik tedavi uygulamalarından sıcak yastık, ultrason ve ev programı olarak gösterilen duvar ve baston egzersizleri ile, çalışma grubundaki hastalar (n=18) ise bunların yanı sıra fizyoterapist tarafından uygulanan üst ekstremite ve skapula PNF paternleri ile tedavi edildi. Hastalar haftada 5 kez olmak üzere toplam 15 seans tedavi aldı. Ağrı değerlendirmesi için Vizüel Analog Skalası kullanıldı. Gözlemsel postür analiz yöntemi ile postüral bozukluklar değerlendirildi. Üniversal gonyometre ile eklem hareket açıklığı ölçümü yapıldı. Skapulanın değerlendirmesinde, "Lateral Skapula Kayma Testi" ve skapula pozisyonu değerlendirmesi kullanıldı. "Omuz Ağrı ve Özürlülük İndeksi" ile hastaların fonksiyonel performansı değerlendirildi.

**Sonuçlar:** Çalışmanın sonucunda, her iki grupta da aktivite sırasındaki ağrının anlamlı olarak azaldığı ve eklem hareket açıklığının arttığı görüldü ($p<0.05$). Fleksiyon ve abduksiyon hareket açıklığındaki artış, PNF grubunda fazla olurken ($p<0.05$), internal ve eksternal rotasyon hareket açıklığında gruplar arasında fark görülmedi. PNF grubunda gece ağrısında azalma tespit edilirken ($p<0.05$), kontrol grubunda anlamlı bir değişiklik olmadı ($p>0.05$). Tedavi sonrasında her iki grupta da skapula pozisyonu değişmedi. SPADI skorları ise her iki grupta da anlamlı olarak azaldı ($p<0.05$).

**Tartışma:** Bu çalışma, adeziv kapsülitli hastalarda PNF uygulamalarının gece ağrısı, omuz fleksiyon ve abduksiyon hareket açıklığı parametrelerine anlamlı katkı sağladığını göstermiştir. Adeziv kapsülit tedavi programına PNF uygulamalarının eklenmesi ile daha iyi sonuçlar elde edilebilecektir.

**Anahtar Kelimeler:** Adeziv Kapsülit; Donuk Omuz; Skapula, Proprioseptif Nöromusküler Fasilitasyon (PNF); OAÖİ (Omuz Ağrı Özürlülük İndeksi)



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## INTRODUCTION

Adhesive Capsulitis (AC) is a condition of shoulder pain and limitation of motion due to progressive fibrosis and contracture of glenohumeral joint capsule. Although, there are many factors that cause AC which is also called frozen shoulder, etiology remains unclear (1,2). The incidence of AC is approximately 3 % in the general population, mostly in women aged 40-70 years (3). There are two types of AC as primary and secondary. Primary frozen shoulder is idiopathic, whereas secondary frozen shoulder exists due to trauma, immobilization, rotator cuff injuries, diabetes mellitus, myocardial infarction, cardiovascular problems, cerebrovascular diseases, psychological reasons or secondary to operation (2).

Limitations of shoulder motions mostly occur in flexion, abduction and external rotation movements. Contracture of shoulder ligaments decreases the volume of capsule and causes limitation of motions. Most cases can be managed conservatively or operatively. Levine et al. showed a 90% success rate with conservative treatment in AC (4). Conservative treatment consists of nonsteroid anti-inflamatory drugs, corticosteroids and conventional physical therapy methods. Physiotherapy applications used in the treatment of AC frequently include the modalities such as superficial and deep heating, ultrasound, therapeutic massage, iontophoresis, phonophoresis, transcutaneus electrical stimulation, laser, manual techniques, soft tissue mobilization, taping and therapeutic exercises (5,6).

Proprioceptive neuromuscular facilitation (PNF) is an exercise modality defined to facilitate the responses of neuromuscular mechanism by stimulating proprioceptors. Effect mechanisms of PNF techniques are stimulating postural reflexes using gravity force to facilitate muscles, using eccentric contractions for muscle activation and utilizing diagonal movement patterns in activation of bi-articular muscles (7). Both stabilization and movement of scapula are essential for appropriate and smooth function of upper extremities (8). However, there is not sufficient research in the literature including upper extremity and scapula PNF patterns in exercise protocol in the upper extremity pathologies particularly AC. The purpose of this study is to investigate the effectiveness of upper extremity and scapula PNF patterns additional to conventional physical therapy techniques in patients with AC.

## METHODS

Current study was performed at Hacettepe University Physical Medicine and Rehabilitation Department. Subjects with diagnosis of unilateral AC participated in the study. Inclusion criteria were having grade 2 or 3 adhesive capsulitis and being 20-70 years-old. Exclusion criteria were having glenohumeral joint (GHJ) osteoarthritis, rotator cuff injury, radiculopathy, romatologic problems, neurologic problems, thoracic outlet syndrome, dislocation, subluxation, infection, fracture, tumor, previous shoulder surgery and being unable to cooperate with exercises. This study was performed on patients who read and accepted the informed consent form, and approved by Hacettepe University Ethical Committee (Decree Law No: HEK 10/110-39).

Thirty-six patients (54.35±10.52 year old) with AC were randomly assigned into two groups (using randomization table) in this prospective designed randomized controlled trial. One physiotherapist followed up the patients in the PNF group (n=18, 11 males) by a standard home exercise program in addition to PNF application. Patients in the control group (n=18, 9 males) were followed up by the same physiotherapist by only home exercise program, with the aim of investigating the effectiveness of PNF, comparatively. Hot pack and ultrasound therapy were applied to both groups before exercises. Patients were treated five times a week, for fifteen sessions. Patients were evaluated before and after the physiotherapy program, by another physiotherapist blinded to the groups.

### Assessments

**Pain:** Individuals scored their pain intensities in three different conditions (resting pain, night pain and pain in activity) on a 0-10 cm Visual Analog Scale (VAS), where 0 means no pain and 10 means excessive pain (9).

**Observation-based posture assessment:** Patients stood on bare feet on a hard and smooth floor in resting position. Physiotherapist observed the patient from anterior, lateral and posterior. Existence of shoulder asymmetry, anterior cervical

**Table 1:** Demographic features of the patients

| Demographic Features | PNF Group (n=18) X± SD | Control Group (n=18) X± SD | z | p |
|---|---|---|---|---|
| Age (year) | 53.94±9.38 | 54.81±11.96 | -0.057 | 0.574 |
| Height (m) | 1.65±0.10 | 1.65±0.08 | 0.000 | 1.000 |
| Weight (kg) | 73.29±12.69 | 78.72±10.53 | -1.426 | 0.161 |
| BMI (kg/m2) | 27.01±5.69 | 29.09±4.23 | -1.803 | 0.074 |

(z: Mann-Whitney U Test) (m: meter, kg:kilogram, BMI: Body mass index)

**Table 2:** Pain intensity and ROM values before therapy

| | | PNF Group (n=18) X± SD | Control Group (n=18) X± SD | z | p |
|---|---|---|---|---|---|
| **VAS (cm) (Before Therapy)** | Resting pain | 2.56±2.93 | 1.99±3.00 | -0.609 | 0.543 |
| | Night pain | 4.83±2.77 | 3.77±3.14 | -1.081 | 0.280 |
| | Pain in activity | 7.02±3.21 | 7.39±6.14 | -0.937 | 0.349 |
| **ROM (°) (Before Therapy)** | Flexion | 124.00±20.41 | 137.50±23.06 | -1.663 | 0.096 |
| | Abduction | 100.28±23.11 | 105.17±27.65 | -0.063 | 0.949 |
| | External Rotation | 38.94±28.14 | 46.06±27.15 | -0.746 | 0.456 |
| | Internal Rotation | 54.33±26.09 | 53.50±25.50 | -0.222 | 0.824 |

(z: Mann-Whitney U Test)

tilt, kyphosis, increased lumbal lordosis, posterior pelvic tilt, scoliosis and hip asymmetry were assessed by inspection (10).

**Range of Motion (ROM):** Flexion, abduction, external rotation and internal rotation movements of the affected shoulder were assessed by a universal goniometer in supine position (9).

**Lateral Scapular Slide Test:** Lateral scapular slide test (LSST) developed by Kibler (11) was applied in three different arm positions. In the first position, both arms were at both sides, and the glenohumeral joint was in neutral position. In the second position, the subjects actively placed both hands on the ipsilateral hips and placed the humerus in medial rotation at 45° of abduction in the coronal plane, and in the third position, the subjects actively extended both elbows and placed the upper extremities in a position of maximum medial rotation at 90° of abduction in the coronal plane. The distance between inferior point of the scapula and corresponding spinous processes of the vertebra in these three different arm positions were measured using a tapeline (cm) (11-15).

**Position of Scapula:** The distance between vertical edge of the spine of scapula and corresponding spinous process, and the distance between spinous process corresponding with the inferior angle of the scapula and T12 spinous process were measured using a tapeline (15). Then, the patients lied in supine position with the arms beside their body. They were asked to relax shoulders, and the distance between acromion and bed was measured. Then, patients pressed their shoulders down to bed strongly (retraction) and the same distance was measured one more time (16).

**Functional Performance:** Functional performance of the patients was assessed by using "Shoulder Pain and Disability Index" (SPADI) (17, 18). SPADI contains 13 items that assess two domains; a 5-item sub-scale measuring pain and an 8-item sub-scale measuring disability. Each item was scored on a 10 cm visual analogue scale (VAS).

**Physiotherapy Program**

**Conventional Therapy:** Hot pack was applied for 20 minutes to the affected shoulders of both groups. Ultrasound was applied for 5 minutes to the shoulder area in a continuous mode at a frequency of 1 MHz and intensity of 1.5 W/cm$^2$. Wall arch (flexion and abduction) and wand exercises (external and internal rotation) were instructed after the heat application in the first session of the therapy and the patients performed these exercises 10 times per every waking hour.

**PNF Application:** "Flexion-abduction-external rotation" (D2F pattern) with elbow straight pattern of PNF with "hold relax" technique (Figure 1) and "anterior elevation"-"posterior depression" of scapula

**Table 3:** Observation-based posture analysis results before and after therapy according to groups.

| Postural Deformities | Groups | Before Therapy | After Therapy | p |
|---|---|---|---|---|
| Anterior cervical tilt | PNF Group (n=18) | 13 (72%) | 10 (55%) | 0,25 |
| | Control Group (n=18) | 12 (66%) | 14 (77%) | 0,5 |
| Kyphosis | PNF Group (n=18) | 14 (77%) | 12 (66%) | 0,5 |
| | Control Group (n=18) | 15 (83%) | 14 (77%) | 1 |
| Shoulder asymmetry | PNF Group (n=18) | 11 (61%) | 9 (50%) | 0,625 |
| | Control Group (n=18) | 12 (66%) | 13 (72%) | 1 |
| Increased lordosis | PNF Group (n=18) | 6 (33%) | 6 (33%) | 1 |
| | Control Group (n=18) | 6 (33%) | 5 (27%) | 1 |
| Posterior pelvic tilt | PNF Group (n=18) | 2 (11%) | 1 (5,5%) | 1 |
| | Control Group (n=18) | 3 (16%) | 3 (16%) | 1 |
| Scoliosis | PNF Group (n=18) | 7 (38%) | 6 (33%) | 1 |
| | Control Group (n=18) | 6 (33%) | 7 (38%) | 1 |
| Hip asymmetry | PNF Group (n=18) | 2 (11%) | 2 (11%) | 1 |
| | Control Group (n=18) | 4 (22%) | 3 (16%) | 1 |

(Mc Nemar Test)

pattern of PNF with "repeated stretch" technique were exercised to the upper extremities of the patients (Figure 2) (11,19).

D2F pattern of PNF and hold-relax technique were preferred to increase the range of affected shoulder motions in this study. "Hold-relax technique" is a relaxing tool based on isometric contractions against to maximum resistance using for improving passive ROM and decreasing pain. Isometric contractions for 5-8 seconds were performed against to maximum resistance for not balking antagonist muscles to contract including rotation at limitation point. Technique was repeated a few times at edge limitation point and then, proceeded. While applying D2F pattern with elbow straight pattern of PNF, the therapist used his hand to hold the patient's upper limb on the opposite side of hip in a posture of shoulder extension/ adduction/internal rotation, elbow extension and forearm pronation. The physiotherapist asked the patient to raise his hand over head. The patient attempted to perform this movement, by doing shoulder flexion/abduction/external rotation. During these movements, the therapist supported the patient's arm with his other hand.

"Repeated stretch technique" was applied to scapula with isometric contractions against to maximum resistance and rapid stretches were performed to muscles at weak points. Voluntary movement was allowed after stretching. Scapular patterns were performed in the side-lying position with the head and neck in neutral alignment. Anterior elevation-posterior depression was utilized, respectively.

**Table 4:** Intragroup analysis of ROM

| ROM (°) | | PNF Group (n=18) X ± SD | z | p | Control Group (n=18) X ± SD | z | p |
|---|---|---|---|---|---|---|---|
| Flexion | BT | 124.00±20.41 | -3.408 | 0.001* | 137.50±23.06 | -2.578 | 0.010* |
| | AT | 155.06±23.45 | | | 146.33±21.55 | | |
| Abduction | BT | 100.28±23.11 | -3.517 | 0.000* | 105.17±27.65 | -2.982 | 0.003* |
| | AT | 137.61±34.75 | | | 119.00±31.48 | | |
| External Rotation | BT | 38.94±28.14 | -3.180 | 0.001* | 46.06±27.15 | -3.182 | 0.001* |
| | AT | 61.17±24.80 | | | 58.28±24.19 | | |
| Internal Rotation | BT | 54.33±26.09 | -2.287 | 0.005* | 53.50±25.50 | -2.048 | 0.041* |
| | AT | 73.22±19.40 | | | 60.00±26.73 | | |

(* p<0,05) (z: Wilcoxon Signed Rank Test) (BT: Before therapy, AT: After therapy)

**Table 5:** Intergroup analysis of ROM after therapy

| ROM (°) | PNF Group (n=18) X±SS | Control Group (n=18) X±SS | z | p |
|---|---|---|---|---|
| Flexion | 155.06±23.45 | 146.33±21.55 | -3.319 | 0.001* |
| Abduction | 137.61±34.75 | 119.00±31.48 | -2.705 | 0.006* |
| External Rotation | 61.17±24.80 | 58.28±24.19 | -1.440 | 0.161 |
| Internal Rotation | 73.22±19.40 | 60.00±26.73 | -1.519 | 0.143 |

(* p<0,05) (z: Mann-Whitney U Test)

**Table 6:** Intragroup analysis of SPADI scores

| SPADI | | PNF Group (n=18) X ± SD | z | p | Control Group (n=18) X ± SD | z | p |
|---|---|---|---|---|---|---|---|
| Pain Score | BT | 33.11 ± 11.29 | -3.516 | 0.000* | 27.31 ± 13.47 | -3.516 | 0.001* |
| | AT | 15.32 ± 11.62 | | | 17.96 ± 12.96 | | |
| Disability Score | BT | 46.33 ± 16.56 | -3.157 | 0.000* | 36.68 ± 21.71 | -3.517 | 0.004* |
| | AT | 19.37 ± 15.93 | | | 23.74 ± 20.47 | | |
| Total Score | BT | 79.44 ± 26.96 | -3.516 | 0.000* | 63.98 ± 34.55 | -3.516 | 0.002* |
| | AT | 34.69 ± 26.43 | | | 41.71 ± 31.95 | | |

(*p<0,05) (z: Wilcoxon Signed Rank Test) (BT: Before therapy, AT: After therapy)

The therapist stood behind the patient and placed one hand on the anterior aspect of the shoulder. The other hand covered and supported this hand. Therapist asked the patient to pull his scapula through his ear for anterior elevation movement. Then therapist placed both of his hands at the vertical bottom of scapula. The directions of the resistance were opposite to movement directions. We preferred anterior elevation-posterior depression of scapula pattern of PNF and repeated stretch technique with the aim of strengthening the weak muscles around the scapula at the affected side.

### Statistical Analysis

Statistical analysis (SPSS 15.0 for Windows) was performed on the data of 36 patients. "Mann Whitney U Test" was used to analyze the pretreatment data. "Wilcoxon Signed Rank Test" analysis was used to compare pain intensity, ROM, and functional performance, while "Mc Nemar Test" analysis was used to compare the postural assessment results of pre and post-treatment. "Mann Whitney U Test" was also used to analyze pain intensity, ROM and functional performance data between the groups and to compare symptomatic and asymptomatic scapula within the groups. Statistical analysis was done with 95% confidence intervals (alpha=0.05).

## RESULTS

In the current study, only 11 of 36 patients (30.6%) with adhesive capsulitis were still working in various jobs and sectors actively, rest of them weren't working (15 retired -10 unemployed) (69.4%). The affected side of 28 patients (77.7%) was non-dominant side. Demographic features of the patients are shown in Table 1.

Signs and symptoms (pain intensity and ROM) of both groups were similar before treatment (p>0.05) (Table 2). Mean symptom duration of the patients was 3.52±3.48 months (1-12 months).

Statistical analysis showed that, pain in activity decreased after therapy (p<0.05) while resting pain didn't diminish in both groups (p>0.05). Also, night pain was not change in the control group (p>0.05)

**Table 7:** Intergroup analysis of SPADI scores after therapy

| SPADI | PNF Group (n=18) X±SS | Control Group (n=18) X±SS | z | p |
|---|---|---|---|---|
| Pain Score | 15.32 ± 11.62 | 17.96 ± 12.96 | -1.979 | 0.048* |
| Disability Score | 19.37 ± 15.93 | 23.74 ± 20.47 | -1.647 | 0.100 |
| Total Score | 34.69 ± 26.43 | 41.71 ± 31.95 | -1.931 | 0.055 |

(* p<0,05) (z: Mann-Whitney U Test)

**Figure 1:** PNF Application to Upper Extremity

**Figure 2:** PNF Application to Scapula

while significantly decreased in the PNF group ($p<0.05$). Change of pain in activity was not significantly different between groups after therapy ($p>0.05$) (Figure 3).

The number of patients with postural deformities (anterior cervical tilt, kyphosis, shoulder asymmetry, increased lordosis, posterior pelvic tilt, scoliosis and hip asymmetry) was not change after therapy in the both groups ($p>0.05$) (Table 3).

Shoulder ROM increased significantly after therapy in both groups ($p<0.05$) (Table 4). But, this increase in range of flexion and abduction movements was higher in the PNF group after therapy ($p<0.05$) (Table 5).

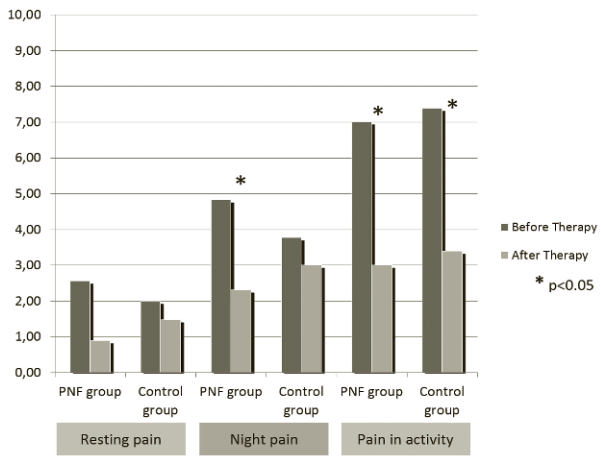


**Figure 3:** VAS scores (cm) before and after therapy (Wilcoxon Signed Rank Test)

There was no difference between the distance of affected and unaffected side of scapula to midline in both groups ($p>0.05$). Also, there was no significant difference between outputs of location of the affected and unaffected side of scapula including elevation, external rotation and posterior tilt parameters ($p>0.05$).

SPADI scores of the patients indicated that pain and disability decreased significantly after therapy ($p<0.05$) (Table 6). Inter-groups of SPADI scores showed that decrease in pain score was higher in the PNF group ($p<0.05$) while decrease in disability score and total score was similar between the groups ($p>0.05$) (Table 7).

## DISCUSSION

The present study was performed to investigate the effect of PNF in AC. It was revealed that, upper extremity and scapula PNF patterns provide additional benefit to conventional physiotherapy applications in night pain, range of flexion and abduction movements, although do not provide benefit in resting pain, pain in activity, internal and external rotation movement parameters in management of AC.

In evaluation, it was determined that affected side of 77% of patients were non-dominant side. In previous studies, they were also indicated that affected side is frequently non-dominant side (20,21). In our study, 69.4% of patients were retired or unem-

ployed. These findings indicate the relationship between inactivity and AC.

Numerous studies showed that PNF techniques are more effective than conventional static stretching techniques to increase flexibility and range of motion (22). This study pointed out that, range of shoulder motion improved more in the PNF group than the control group. But, this difference was not significant for external and internal rotation movements, though was significant for flexion and abduction movements. It is thought that PNF exercises expedite neuromuscular responses by stimulating proprioceptors. Thus, they are more effective in increasing range of motion when compared with single direction and single plane exercises (23). D2F pattern exercised to PNF group was not include internal rotation movement and applying PNF pattern with straight elbow couldn't provide significant difference in external rotation movement.

PNF "flexion-abduction-external rotation pattern" defined by Voss and Ionta (24) includes flexion movement in sagittal plane, abduction movement in frontal plane, and external rotation movement in transverse plane. Abduction movement exists in GHJ and is associated with external rotation (25, 26). In external rotation greater tubercle shifts acromion and coracoacromial ligament to the postero-inferior and allows humerus abducting. Shoulder flexion above 90º is associated with internal rotation (25). In this study it iswasaimed to increase the range of GHJ motion and decrease pain with hold-relax technique in D2F pattern, to increase muscle strength around scapula and active joint movement with repeated contractions (repeated stretch) in anterior elevation-posterior depression scapula patterns. Furthermore, it is thought that PNF technique would be effective to re-correct the location of the affected scapula, by repairing scapulo-humeral rhythm which is probably impaired in AC, through the direction of diagonal forces which effects GHJ and scapula-thoracic exercises. In a recent study it was shown that, pain alleviated and flexion range of motion increased, in the group which was treated with scapula-thoracic exercises. Eventually, as our results, prescribing scapula-thoracic exercises beside exercises for increasing GHJ motion may be effective in decreasing pain and enhancing range of motion by correcting impaired scapulo-humeral rhythm in patients with AC (9).

In this study, there was no significant difference in location of scapula between affected and unaffected sides before and after treatment in patients with AC. Our results related to location of scapula, correspond the results of the study by Nijs et al. (16), performed in patients with shoulder pain. Prolonged duration of symptoms in patients with functionally impaired shoulders, cause compensator mechanisms which occur due to use of affected shoulder in daily living activities (27). Standard deviation of symptom duration was quite high in our study. This may be due to lack of a predefined lower limit for duration of pain and movement limitation. This limitation maintained the location of affected side scapula of the patients to alter.

At the end of the treatment, it is noticed that, resting and night pain was not reduce, but pain in activity significantly decreased in control group, whereas both night and activity pain significantly decreased in the PNF group. Superficial and deep heating generated analgesia and increased circulation and metabolism by causing vasodilatation. When elevated heat in connective tissue combines with stretching, the viscoelastic affect increases. This might cause patients to perform exercises easily and thus, increase painless joint motion and decrease the intensity of pain during activities of daily living.

The most common postural dysfunction involving shoulder has been described as increased thoracic kyphosis, forward head, round shoulders, abducted and forward –tipped scapula and sub-occipital extension (10). The patients who participated in this study were evaluated by observational posture assessment and it is revealed that 25 of 36 patients had forward head, 29 patients had increased thoracic kyphosis, 23 patients had shoulder asymmetry, 13 patients had scoliosis, 12 patients had increased lordosis, 5 patients had posterior pelvic tilt, 6 patients had hip asymmetry. Pathology originated from a joint cause biomechanical and postural alteration, commonly in most close body parts and this effect decreases through the periphery (10). In this study, at the end of treatment, 3 anterior cervical tilt, 2 increased kyphosis, 2 shoulder asymmetry, 1 posterior pelvic tilt, 1 scoliosis deformity recovered in the PNF group. On the other hand, most of deformities in the control group didn't change or a few deformities increased after

treatment. But this difference was not significant between pre and post treatment for both groups. This might be due to increased proprioceptive inputs and postural awareness in patients of the PNF group. Stimulations which start from peripheral sensory receptors such as proprioceptors take sparkle role for muscle activation and coordination. This mechanism might be effective in improving postural awareness and postural correction in the PNF group patients.

While designing this study, we thought that PNF or conventional therapy would correct the scapular dyskinesia in patients with AC. But, we discovered that there was no scapular dyskinesia in patients who attended the study. The lack of a predefined lower limit for duration of signs and symptoms, might have affected the general distribution of data. Also, using clinical scales to measure the location of scapula could adversely affect the reliability of assessments. Therewithal, postural deformities were assessed by observation. Using objective postural assessment techniques (such as videotaping and computer-aided analysis, direct or instrumental techniques) for comparing other results would be more reliable in order to investigate the effectiveness of PNF in patients with AC.

To our knowledge, there is no study in the literature investigating the effectiveness of upper extremity and scapula PNF patterns used with PNF techniques in problems such as pain, range of motion and postural dysfunctions in patients with AC. We are of the opinion that, this research, which was planned and performed according to recent PNF approaches, will guide future clinic applications and studies.

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