5-10-2017

The Effects of Proprioceptive Neuromuscular Facilitation Scapular Motor Control Intervention on the Rehabilitation of Shoulder Impingement Syndrome

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OBJECTIVE: Shoulder impingement syndrome (SIS) accounts for 44-65% of total shoulder complaints. Previous research has analyzed the effectiveness of scapular-focused SIS treatment, but little research has been performed evaluating the effectiveness of proprioceptive neuromuscular facilitation (PNF) treatment. The aim of this study is to examine the effects of PNF scapular motor control intervention for SIS. METHODS: Patients from the Roseville Medical Center ages 18-64 were randomized to a PNF-treatment or control group to undergo a 4 to 6 week intervention. Prior to each visit, patients completed the Disabilities of the Arm, Shoulder and Hand (DASH) functional survey and evaluated their pain using the Numeric Pain Rating Scale (NPRS). Control and treatment groups received equivalent treatment with the exception of PNF scapular reeducation with the treatment group. RESULTS: No significant difference in improvement ($p < 0.05$) between the control and treatment groups was determined. Both groups modeled significant improvement in DASH scores from initial to final session ($p = 0.023$, $\bar{x} = 9.202$, $SD = \pm 12.113$). CONCLUSION: Both groups displayed significant DASH score improvements demonstrating both protocols reduce pain experienced while performing daily activities. Results reveal that both PNF and conventional treatment may be sound protocols in the treatment of SIS.

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Key Words: Shoulder Impingement Syndrome; Rehabilitation; Proprioceptive Neuromuscular Facilitation (PNF); Soft Tissue Mobilization; Numeric Pain Rating Scale (NPRS); Disabilities of the Arm, Shoulder and Hand (DASH)

Introduction:

Shoulder impingement accounts for a large percentage of shoulder injuries. Projected medical cost incurred in shoulder impingement is an estimated $1-2 billion annually (Nakra, N. et. al., 2013). Research has found the effects of manipulative therapy and proprioceptive feedback transmitted by deep level receptors may improve neuromuscular control in shoulder movement patterns (Senbursa, G. et. al., 2007). Soft tissue mobilization (STM) in combination with PNF has been shown to produce immediate improvements in glenohumeral external rotation at 45° of shoulder abduction and overhead reach while also reducing pain (Al Dajah, S.B., 2014). Additional studies report inclusion of PNF in conventional treatment for SIS produces significant improvement in shoulder function in comparison to conventional treatment alone (Nakra, N. et. al., 2013).

This study aims to evaluate the effectiveness of PNF scapular motor control intervention as a form of SIS therapy. It is hypothesized that the addition of PNF in the treatment of SIS will significantly improve shoulder function and reduce pain in comparison to conventional treatment alone.

Methods:

Subjects involved in this study were recruited from the Roseville Medical Center with a diagnosis of SIS and be between the ages of 18-64 ($\bar{x}$ = 49.08, SD= ±12.63). A total of 23 participants were recruited as meeting the inclusion criteria. All subjects in the study were referred by their physician to the Roseville Medical Center with a diagnosis of SIS to receive physical therapy. Patients received verbal explanation of the consent form and were allowed to ask for any further clarification. Of the 23 recruited participants, 12 subjects completed the required length of treatment, as seen in table I, and were randomly assigned a patient number based on the order in which they arrived at the clinic to begin treatment. Odd numbered patients were assigned to the PNF scapular motor control treatment group (n= 6), while even numbered patients were assigned to the control group (n= 6).

Upon each visit, patients filled out the DASH functional survey to assess difficulty experienced while performing daily activities. Additionally, patients were asked to demonstrate range of motion (ROM) in three directions including elevation, horizontal adduction and reaching behind the back. Participants rated these movements using a numeric pain rating scale (NPRS) with 0 being no pain and 10 being the worst possible pain. Impingement tests, including the Neer's and Hawkins-Kennedy, were rated using the same NPRS. Scores for each patient were recorded prior to each treatment session.

Both groups received the following treatments: 'Scapular specific exercises'; 'Rotator cuff exercises'; Soft tissue and 'glenohumeral joint mobilization' performed in both seated and supine positions including strumming, direct pressure, parallel and perpendicular technique, and muscle play directed at restricted structures in the shoulder girdle; 'Upper quarter flexibility'.

The treatment group and control group received different variations concerning scapular mobilization. The control group received specific scapular recruitment exercises alone while the treatment group received scapular mobilization incorporating a contract-relax technique to gain scapular mobility prior to specific scapular recruitment exercises. The additional PNF scapular motor control treatment consisted of performing a re-education process involving facilitation of axio-scapular muscle recruitment in 2 diagonal patterns using the progression of passive movement into the pattern, active assisted movement, and finally manual resistance into the desired diagonal quadrant. This process was repeated for each of the scapular diagonal quadrants which reflect the 3-dimensional positions necessary for functional shoulder movements.

'Scapular specific exercises' were performed in each of the groups. Prescribed exercises included the prone on elbow push up, standing inferior trapezius exercise and scapular re-setting exercise. The prone on elbow push up enabled isolation of the serratus anterior in protraction and controlled retraction of the scapula on the thorax. In a prone position with their forearms and arms directly under their shoulders, patient's push on their forearms and round their thoracic spine so that the scapula is maximally protracted on the thorax by the serratus anterior. The standing inferior trapezius exercise isolates recruitment of the inferior portion of the trapezius. The patient allows their chest to drop toward the wall and squeeze their scapula down and back to recruit the lower aspect of scapular musculature.

'Rotator cuff exercises' included standing elevation, horizontal abduction, and a unilateral "W" involving external rotation and scapular posterior tilt. 'Glenohumeral joint mobilization' involved directing passive motion to restore periarticular soft tissue mobility in various aspects of the capsule based on individual patient presentation. 'Upper quarter flexibility' consisted of pectoralis and latissimus dorsi stretching as needed. This progression of interventions was gradually introduced based on patient tolerance and individual presentation.

Results:

The independent samples T-test showed no significant difference ($p < .05$) in improvement between the control and treatment groups as seen in table II. Both the control and treatment group modeled significant improvement in DASH scores from initial to final session using a paired samples T-test ($p = 0.023$, $\bar{x} = 9.202$, $SD = \pm 12.113$), but other variables were not significant as seen in table III.

Discussion

The aim of this study was to assess the effectiveness of conventional and PNF protocols in the treatment of SIS. Data revealed no significant difference comparing conventional treatment to PNF. Further analysis demonstrated that over the course of treatment both conventional and PNF protocols produced significant reduction in DASH scores. Patients demonstrated decreased pain experienced while performing functional activities of daily living indicating that both PNF and conventional treatment may be sound protocols in the treatment of SIS.

Lack of significant difference between conventional and PNF treatment in this study may have resulted due to limited time frame of motor recruitment training. Results may indicate that the facilitation of such neurophysiological pathways may require a longer training period in order to solidify pattern recruitment. Further research could extend the time frame of study to examine the impact of increased duration utilizing neuromuscular facilitation.

Limitations of this study include the use of subjective measurements for pain tolerance. Every individual has a variable pain tolerance which can be influenced by external factors such as stress, overall health, and various activities that vary day to day. To reduce subjective skew of results, future research should aim to incorporate more objective quantitative measurements such as assessing ROM with a goniometer to assess changes and improvements.

Future research is necessary to further investigate the optimal time frame of PNF intervention necessary to produce significant results. A prolonged study examining the effects of strengthening exercises on shoulder impingement syndrome demonstrated significant improvements beginning at week 6 of the intervention (Roy, J. et. al., 2009). Such a study suggests that a minimal time period of 6 weeks may be required to produce significant improvements in neural adaptations modeling improved synchronization and recruitment of motor unit firing.

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APPENDIX A

Table I. Subjects, age, and weeks of treatment completed.

Subject	Age	Weeks Completed
1	28	6
2	63	5
3	60	4
4	63	6
5	63	4
6	32	5
7	41	4
8	54	6
9	52	6
10	42	6
11	37	5
12	54	4

Table II. Independent samples t-test results comparing the DASH score, elevation, adduction, reaching, Neer's and Hawkins tests between control and treatment groups.

Variable	P-Value
DASH	0.197
Elevation	0.111
Adduction	0.307
Reaching	0.649
Neer's	0.282
Hawkins	0.591

Table III. Paired samples t-test results comparing pre and post results among DASH score, elevation, adduction, reaching, Neer's and Hawkins tests.

Variable	P-Value
DASH	0.023
Elevation	0.088
Adduction	0.138
Reaching	0.488
Neer's	0.152
Hawkins	0.517

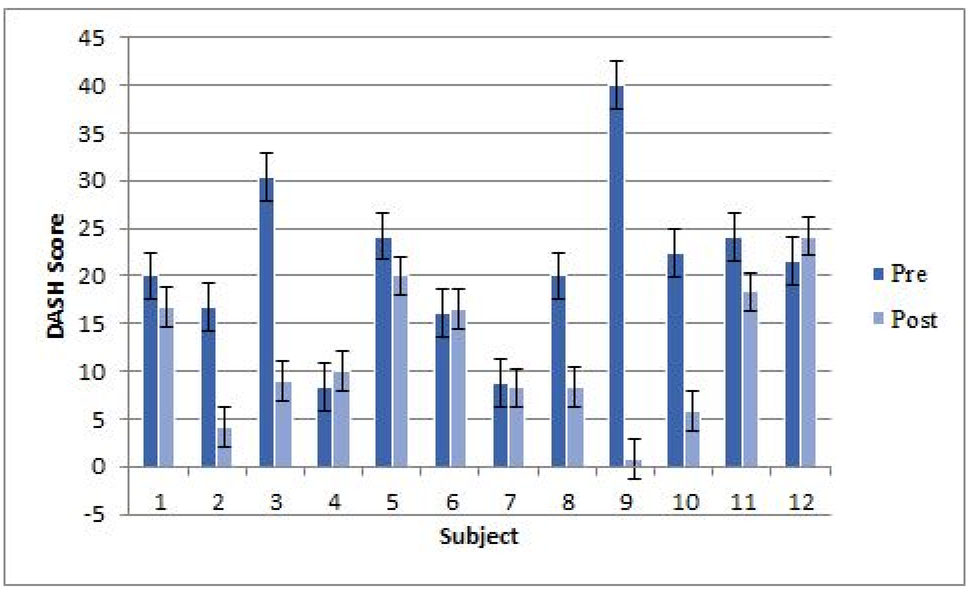

Figure 1. Comparison of DASH scores between pre and post treatment for all subjects.