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Will Musculoskeletal Conditions of Shoulder Affect the Hand Function and Hand-Eye Coordination? A Cross-Sectional Analysis

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Abstract

Objective: To analyze the Hand Function (HF) and Hand-Eye Coordination (HEC) among subjects with shoulder conditions resulting in pain and disability. **Methodology:** In these cross-sectional 47 subjects with selected shoulder pathology between 30 to 60 years participated. Shoulder pathology was measured in terms of pain and disability using the SPADI scale. These values were correlated with Purdue pegboard and Balloon tossing task and Wall Ball Bounce task. **Results:** Spearman rank correlation analysis of SPADI pain component revealed that there was a negative correlation with HF (R= -0.596, p<0.001), but there was significant correlation with HEC1 (R= -0.260, p= 0.078) and HEC2 (R= -0.217, p= -0.144). Though there was no correlation a negative relationship was observed between the variables. In the correlation of SPADI disability component there was a perfect negative correlation with HF (R= -0.870, p<0.001), with HEC1 (R= -0.588, p<0.001) and HEC2 (R= -0.541, p<0.001). **Conclusion:** This study concludes that shoulder pain negatively influences the Hand Function, whereas the shoulder disability negatively influences both Hand Function and Hand-Eye Coordination. The therapist should consider assessing and treating HF and HEC in patients with shoulder pain and disability in the future.

Advances in Knowledge

- Physiotherapists are suggested to include assessment of hand function as a part of regular musculoskeletal assessment for shoulder pain.
- We suggest to physiotherapist that even if the shoulder is full and free if the hand is not in the functional state the rehabilitation of the shoulder is not complete.
- Following this study, people who treat shoulder conditions will give due attention to hand function training as a part of shoulder pain rehabilitation which is seldom practiced currently.

Application to Patient Care

Based upon the study recommendations the patients with shoulder pain

- Will be trained for hand function activities too.
- The patients will be rehabilitated completely to become functionally fit to take part in skilled activities as well
- The patients work efficiency will be enhanced

- These patients will utilize less energy for hand function activity that can contribute to the endurance there by promote the work efficiency.

Introduction

Hand function assessment has been included as mandatory in physical examination of many neurological conditions, where the Hand Function is affected viciously, apart from other functions of the upper limb. A classic example of such a condition is hemiplegia following stroke [1]. The assessment of Hand Function helps in the intervention designing and also in the prognosis of stroke rehabilitation. When there is no direct impairment of the hand, like elbow and shoulder impairments, the HF examination is ignored. This is true in the case of most of the musculoskeletal conditions that affect the shoulder. But the fact is, proximal stability is a prerequisite for distal mobility, be it a gross motor activity or fine motor activity. This is true in both the upper limb and lower limb where the proximal muscles significantly

contribute to the distal muscle activity. While attempting to grasp any object with hand, the resultant is simultaneous muscle contraction at the elbow and shoulder [2,3].

It is proved in the past that before the limb muscle contracted the trunk and proximal muscles contracted in an anticipatory manner to give a proper background for distal muscle activity [4]. This has strong physiological support as many neurons of the motor cortex have outputs that innervate a spinal motor neuron pool of both proximal muscles and intrinsic muscles of the hand. This claim is reinforced when it was proved by the Spike-triggered averaging of EMG activity which showed that neurons of the motor cortex have either facilitatory or inhibitory effects on the motor neuron pools of shoulder, elbow, wrist and hand muscles [5]. When the motor cortex is stimulated through a weak stimulus, a monosynaptic Excitatory Postsynaptic Potential (EPSPs) is produced in the motor neuron of the distal and proximal muscles of both forelimb and the hind limb [6]. In most of the shoulder conditions that present with pain and functional limitations, there is always an associated impairment in muscles, skeleton, ligaments, cartilage, and nervous system, which results in musculoskeletal dysfunction. Despite a strong physiological and anatomical relationship between the proximal and distal musculatures being established scientifically, there exists no consideration for Hand Function assessment when assessing and treating painful shoulder. This study was conducted to analyze the HF and HEC among subjects with shoulder conditions resulting in pain and disability.

Methodology

This cross-sectional study was conducted at the outpatient department of UCA College of Physiotherapy, Chennai from August 2018 to August 2019. Ethical clearance was obtained for the study from the institutional ethical committee, Saveetha University on 12th April 2018. All the subjects who participated in the study were clearly explained about the study before participation and were requested to sign an informed consent. A total number of 82 subjects with shoulder pain were screened for the study inclusion criteria and 47 subjects were selected for the study.

Inclusion criteria

- Both males and females between 30 to 60 years were selected for the study.
- Subjects with a history of shoulder dysfunction for a minimum period of one-month duration and a maximum of 42 months. Shoulder dysfunction was defined for this study as "any condition of the shoulder that has resulted in path-mechanical changes at shoulder joint complex which has resulted in the altered functional activity of the shoulder".
- A variety of shoulder conditions like bicipital tendonitis, supraspinatus tendonitis, capsulitis at Glenohumeral Joint (GHJ), degenerative conditions of the shoulder complex, were included in the study.

Exclusion criteria

- Subjects who had a history of fracture, internal fixation anywhere in the affected upper limb or cervical spine, subjects with bilateral shoulder complaints, any associated problems of the affected upper limb or the cervical spine that might influence the HF were excluded from the study.
- Subjects with altered sensation, altered eyesight (using a spectacle), severe systemic problem and general health depleted subjects were not considered for the study.
- All the subjects were assessed for a shoulder disability, hand function, and hand-eye coordination skills. SPADI scale was used to evaluate the subject's severity of pain and the associated disability among the samples [7].

Apart from this shoulder evaluation, the Purdue pegboard task was administered to find the hand function/dexterity. Two blinded assessors were used in the analysis of hand-eye coordination. One assessor was responsible for measuring the time using a standard stopwatch, and the other was used to monitor the task for both HF and HEC tests.

There were three tasks performed by every subject three times with a gap of 60 seconds between each attempt. The first subtask required the subject to place as many pegs as possible in 30 seconds in the target holes provided in the pegboard. This task was performed with both hands consecutively. For the first attempt hand was selected randomly. Task number two required the subjects to place as many pegs as possible using both hands, by placing pegs simultaneously [8]. The third task required the subject to place the peg, then the washer and followed by the collar in a sequence prescribed by the guidelines. (Leslie, Davidson and Batey, 1985) A battery of hand-eye coordination tests was administered to the patient as follows.

Drill 1-Balloon tossing task: The subject had to bounce a balloon vertically up, back and forth with the affected hand, as long as possible, followed by the normal hand. The task had to be continued as long as possible and the subjects were not allowed to catch the balloon. The task was repeated three times on each hand. The best score for each hand was added and then used for statistical analysis.

Drill 2-Wall Ball Bounce task: The subjects stood 2M away from a wall and tossed a tennis ball onto the wall in a self-passed manner. The subject had to catch the ball on return with a single hand at first attempt without fumbling. The number of times the subject successfully performed the task in 60 seconds was measured. The test was performed with both hands. The task was performed only once and the score thus obtained for each hand was added and was used for statistical analysis.

Results

A total number of 94 subjects were screened for the study out of which 58 subjects fulfilled the selection criteria. Out of the selected, 11 subjects opted out during the actual performance of the study tests, particularly the hand-eye coordination activity. The reasons for unwillingness to participate were apprehension to move, failure to succeed in task and few did not cite any reason but withdrew. 47 subjects participated in the study and completed all the tests. The demographic details of the subjects are provided in (**Table 1**).

Criteria	Numbers
Age	
30-40 years	21
40-50 years	16
50-60 years	10
Sex	
Male	31
Female	16
Involved side	
Dominant hand	29
Non dominant hand	18
Duration of ailment	
1-6 months	16
7-12 months	12
13-36 months	13
More than 3 years	6
Conditions	
Capsulitis at GHJ	13
Supraspinatus tendinitis	11
Rotator cuff injuries	9
Bicipital tendinitis	7
Degenerative conditions of GHJ	5
Combined	2

Table 1: Demographic data of the participants.

The scores of SPADI were correlated with the scores of Purdue pegboard scores and the hand-eye coordination scores using a Spearman's correlation as the data were ordinal. SPSS version 24 was used for the data analysis. The SPADI scale was correlated to the HF and Hand-eye coordination using its pain and disability component separately, for the sake of in-depth analysis. We believed that such analysis will give an idea about which component is strongly related to the Hand Function and Hand-eye coordination.

The mean and standard deviation values of SPADI pain component for the 47 subjects was 25.3 (3.92), SPADI disability component was 28.8511 (5.15), HF scores on PURDUE pegboard was 72.31 (4.64), hand-eye coordination in test 1 was 20.0426 (3.57) and test 2 was 39.4043 (3.23).

The Spearman's rank correlation test for the SPADI pain component revealed that there was a negative correlation with HF (R= -0.596, p< 0.001), but there was no correlation with HEC1 (R= -0.260, p= 0.078) and HEC2 (R= -0.217, p= -0.144). Though there was no correlation a negative relationship was observed between the variables. In the correlation of SPADI disability component there was a perfect negative correlation with HF (R= -0.870, p<0.001), with HEC1 (R= -0.588, p<0.001) and HEC2 (R= -0.541, p<0.001). In all the correlation a clear negative relation prevailed. The scatter plot representation of the data is shown in (**Figure 1 and 2**).
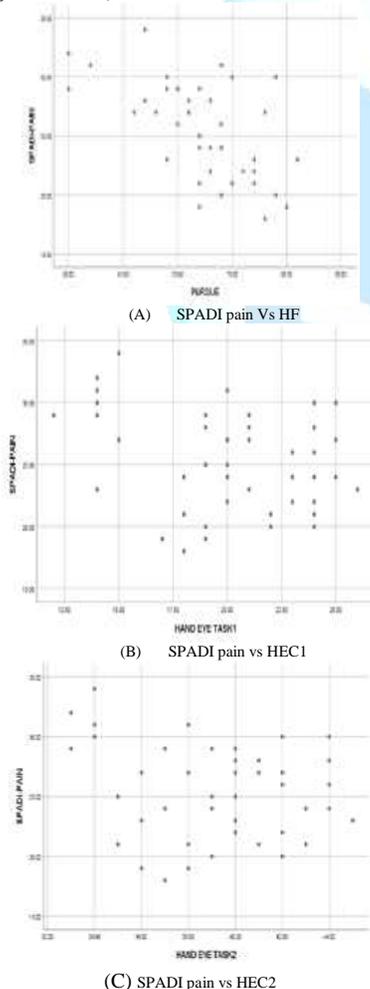

(A)   SPADI pain Vs HF

(B)   SPADI pain vs HEC1

(C) SPADI pain vs HEC2

Figure 1: Correlation between SPADI pain component with HF and hand eye coordination.

(A) SPADI disability Vs HF

(B) SPADI disability vs HEC1
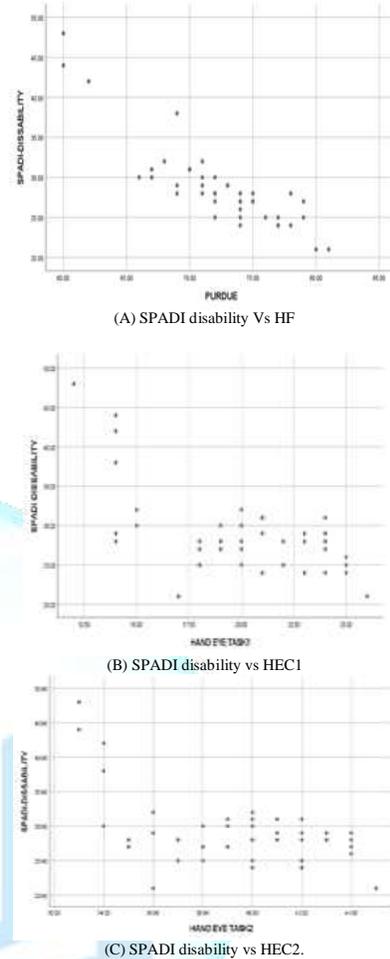

(C) SPADI disability vs HEC2.

Figure 2: Correlation between SPADI disability component with HF and hand eye coordination.

Discussion

In this study, an effort was taken to find out the influence of shoulder Pathology in HF and hand-eye coordination. Such a comparison was needed because we perceived that proximal stability was a prerequisite for any distal performance. For testing this hypothesis we adopted a cross-sectional study where we correlated the pain and disability component associated with the shoulder Pathology with HF and hand-eye coordination of the affected limb. For this, we selected an age group that was vulnerable to shoulder pathology. Almost 45% of the subjects fell into the age group of 30 to 40 years out of which 90% of the subjects had rotator cuff injury and bicipital tendonitis. 34% of the subject fell into 40 to 50 years category who were predominantly suffered from supraspinatus tendonitis and adhesive capsulitis. Subjects with 50 to 60 years constituted just 21% who are predominantly affected by the degenerative condition of glenohumeral joint, capsulitis and combined presentation. In the study male and female ratio was 2 is to 1 respectively. Male suffered more tendinopathy (63%) whereas females suffered more with capsulitis and degenerative conditions (59%).

This can be attributed to the work nature of the male and female. 42% of the dominant hand pathology involved supraspinatus tendonitis and bicipital tendonitis, which was in line with a systematic review which stated that the vulnerability of rotator cuff tear is very higher on the dominant side [9]. 39% of the non-dominant hand involvement was

capsulitis and degenerative condition which was in line with Katsuhiro Toda's study which concluded that the right and dominant shoulders were less frequently affected in subjects with frozen shoulder. Industry analysis we found that a variety of pain was in subjects to had an acute presentation of 1 to 6 months duration, whereas disability was more in case of chronic presentation (more than 24 months). This trend is similar to the reports in 2018, which stated that the disability rate hiked with duration of ailment that resulted in more absenteeism among workers suffering from a wide range of medical conditions [10,11].

The analysis of the current study displayed an inverse relationship between the variables, which signifies that when pain and disability of the shoulder were on a raise the HF and HEC were compromised correspondingly. This is the first success of the study, where the hypothesis is not been explored before. As there was no prior documentation, comparing shoulder conditions with HF and hand-eye coordination, our effort can be considered unique and novel. There are previous studies that documented the relationship between the shoulder and hand musculature. The shoulder muscles were found to be active while the hand performed strong prehension activity. The rotator cuff muscles, which are the stabilizers of the shoulder, were more influenced than mobilizes during the hand activity recorded by EMG analysis [12,13].

Similarly, the current study results showed shoulder pain was associated significantly with the Hand Function, but there was no significant influence on Hand-Eye Coordination whereas shoulder disability was significantly associated with poor HF and HEC. This clearly states that shoulder disability rate influenced the HF and HEC more than shoulder pain. As a matter of known fact disability in such conditions develops in due course of time where the shoulder ranges of motion deteriorated, limiting the freedom of movement. Some studies showed that prolonged hand immobilization or injury can cause weakness in shoulder muscles and the current study proved that this may happen vice versa too. The current study did not use more objective measures like EMG, which may be a limitation but the outcome measures used for the study are highly valid and reliable. Future studies can concentrate on comparing other variables like handgrip strength the effect of different body posture, shoulder position in the relationship of hand and shoulder and influence of restricted shoulder ROM in hand performance [14-16].

Conclusion

This study concludes that shoulder pain negatively influences the Hand Function, whereas the shoulder disability negatively influences both hand function and hand-Eye Coordination. The major clinical inference from this study is that the therapist should consider assessing and treating Hand Function and Hand-Eye Coordination in patients with shoulder pain and disability.

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