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The Effect of Shoulder Pain to Handgrip Strength and Knee Pain to Quadriceps Strength

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Abstract: ***Shoulder and knee pains are disabling pains. Understanding the causes and effects of these pains is vital for us to perform our daily task without any restriction and to be able to live our lives hassle-free.The aim of this study is to determine the effect of shoulder pain to hand grip strength, as well as, the effect of knee pain to quadriceps strength. Shoulder and knee strengths were measured using a hand-held dynamometer. Shoulder and knee pain were assessed using questionnaires such as TDASH and WOMAC. The overall results of the present study showed that shoulder pain weakens hand grip strength, at the same time, knee pain weakens quadriceps strength. Furthermore, TDASH score were predominantly higher in patients with shoulder pain. On the other hand, knee pain assessment showed no conclusive data.***

Keywords: knee pain, quadriceps muscle, power, rotator cuff

1. Introduction

Pain plays an integral part in bestowing the body precautionary signs in cases of coercions, genuine or impending tissue damage. Moreover, pain on one part of the body may poorly affect the performance of the tissue or organ in the same affected area and may even go farther affecting other parts of the body and putting its functions at risk. The hand, undeniably, is one of the most important parts of our body as it partakes in almost all of our day-to-day tasks. A study even stated that the strength in our hand grip is depicted to be a conjecturer of our over-all body power (White, et al. 2013). Equally important is our leg which is critical in terms of our movements. Thus, feeling of pain in either of these body parts may arbitrate greatly our regular routines.

Shoulder pain is communal that could be felt at a long period of time and may result to the incapacity of the person to perform his responsibilities (Gill, et al. 2013). Several studies noted that the shoulder is the third supreme usual spot of muscoskelatal pain in the over-all populace (Bilberg, et al. 2015; Urwin, et al. 1998). Shoulder pain can be a consequence of certain circumstances which includes problems on the rotator cuff tendons, volatility of the glenohumeral joint, pasty capsulitis, synovitis and osteoarthritis (Rechardt, et al. 2010). Additionally, studies stated that people with rheumatoid arthritis have an increased risk of compromised shoulder functionality as a repercussion to swelling (Bilberg, et al. 2015; Urwin, et al. 1998). Moreover, some studies detailed that shoulder impingement syndrome (SIS) is a generally detected shoulder ailment in the primary health cares (de Witte, et al. 2011; Horsley, et al. 2016; Seitz, et al. 2011).

Knee pain on the other hand is the trademark indication of knee osteoarthritis (OA) and the foremost reason why people seek out for medical attentions (Creamer, et al. 2000; Dieppe, et al. 1997; Glass, et al. 2013; Hannan, et al. 2000). It is also stated that the predominance of knee discomforts among elderlies in the United States has amplified by 65% over the last 20 years (Glass, et al., 2013). The wide-ranging occurrence and frequency of knee OA has been described to upsurge by as much as 10 times among the younger generations, distressing approximately 33.6% of people with less than 65 years of age or a prevalence of 1 out of 10 (Bhatia, et al. 2013; Magrans-Courtney, et al. 2011; Ringdahl and Pandit 2011). Knee pain is believed to be brought about by biological and psychosocial factors (Glass, et al. 2013). Biological factors may include but not limited to quadriceps muscle weakness but this is not yet being proven by any evidence (Glass, et al. 2013). Measures to lessen knee pain and improve its functionality includes certain exercises (Glass, et al. 2013; Baker and McAlindon 2000; Thomas, et al. 2002).

Shoulder and knee pains are disabling pains. Understanding the causes and effects of these pains is vital for us to perform our daily task without any restriction and to be able to live our lives hassle-free. The result of this study will help us to determine/further avoid or at least minimize the effects these pains can cause and to be able to impart the result to people not yet knowledgeable and unconsciously take for granted the pain they constantly feel. In general, this study aims to fully understand the associationbetween shoulder pain and hand grip strength, and knee pain and quadriceps strength. However, to the best of our knowledge, there are still no existing studies or researches that could define the correlation between shoulder pain and hand grip as well as knee pain vis-à-vis quadriceps strength that would have greatly help us to better understand the basis and effect of these pains. Thus, this study takes it aim to bring light to this question.

2. Methods

This is a cohort study conducted among 50 patients from the Orthopedic Outpatient Department of King Abdulaziz University Hospital, Jeddah, Saudi Arabia. More than half of these patients are complaining of knee pain while the remaining patients are complaining of shoulder pain. Permission was first obtained before conducting this study at the aforementioned hospital. An informed consent was also acquired from the participating body after completing the questionnaires given to them. In addition, in performing actual measurement, the hand grip and quadriceps strengths were measured using hand-held dynamometer to ascertain patient's position in the study and establish control.

This study was analyzed using IBM SPSS version 23. A simple descriptive statistics was used to define the characteristics of the study variables through a form of counts and percentages for the categorical and nominal variables while continuous variables are presented by mean and standard deviations. To establish a relationship between the two group means, an independent *t*-test was used. These tests were done with the assumption of normal distribution. Otherwise, Welch's *t*-test for the two group was used as an alternative. Lastly, a conventional p-value <0.05 was the criteria to reject the null hypothesis.

3. Results

The demographic data of the 50 respondents from KAUH is presented in Table 1. The mean age of the population was 53.48 (SD 15.0). The mean height and weight of the patients were 156.52 (SD 29.8) and 81.76 (SD 16.0), respectively. Body mass index (BMI) was computed and the mean was 31.39 (SD 7.1). From the computed BMI, 14.3% of the respondents were found to have normal weight-for-height, 42.9% were overweight, and the other 42.9% were obese. Forty-four percent of the patients were male, while 56% were female.

Table 1: Demographic data of the 50 patients from KAUH, Jeddah

Variable	N	Min	Max	Mean	SD
age	48	20	73	53.48	15.0
height	29	10.00	178.00	156.52	29.8
weight	33	58.00	125.00	81.76	16.0
BMI	28	22.80	50.70	31.29	7.1
		Count		%	
Total		50		100.0	
BMI	Normal Weight	4		14.3	
	Overweight	12		42.9	
	Obese	12		42.9	
	Missing	22			
sex	male	22		44.0	
	female	28		56.0	

At the duration of the interview or survey, the physical condition of the patients was also assessed, as shown in Table 2. Among the 50 respondents, 36% were engaged in physical activities, while the remaining 64% were not. Shoulder pain was experienced by 36% of the patients. Seventy-six percent of the patients were suffering from knee pain, which may be related to their medical condition, as it was noted that 47.4% of the patients were diagnosed with osteoarthritis (Supplementary Table 1). Medical history included diagnosis of Diabetes Mellitus (DM) and hypertension (HTN). Thirty-four percent of the respondents were diagnosed with DM, while 42.6% were hypertensive.

Table 2: Physical characteristics of the 50 respondents

Variables		*Count*	*%*
Total		50	100.0
exercise	yes	18	36.0
	no	32	64.0
Total		50	100.0
shoulder pain	yes	18	36.0
	no	32	64.0
knee pain	yes	38	76.0
	no	12	24.0

Hand grip strength and shoulder pain assessment using different parameters

Hand grip strength in the affected (AFF) and the not affected (NON) shoulders was assessed (Table 3). Although AFF shoulder was slightly above the significant p-value (0.055), it is still important to note that the patients who experienced pain in the AFF shoulder had higher hand grip strength (32.61 ± 20.5) than those who did not experience pain (10.80 ± 24.1). The hand grip strength in patients without pain in the NON shoulder was significantly higher (57.00 ± 25.2) than those who experienced pain (37.74 ± 23.8), with p-value 0.017. Moreover, the hand grip strength in patients who experienced pain in the NON shoulder were slightly higher (37.74 ± 23.8) than those who experienced pain in the AFF shoulder (32.61 ± 20.5). TDASH scores were found to be significant at p-value of 0.001. TDASH scores were significantly higher in patients with shoulder pain (41.38 ± 24.7) than those without pain (8.15 ± 23.8). D24 and D25 scores (p value <0.001) in patients experiencing shoulder pain, 3.71 ± 1.1 and 3.86 ± 1.2, respectively, were also significantly higher than those without shoulder pain, 0.50 ± 1.0.

Table 3: Assessment of shoulder pain and hand grip strength measurements

Variables	Total	Shoulder pain		p-value
		yes	no	
AFF shoulder	27.87 ± 22.7	32.61 ± 20.5	10.80 ± 24.1	0.055
NON shoulder	49.20 ± 26.2	37.74 ± 23.8	57.00 ± 25.2	0.017[a]
TDASH	28.78 ± 29.0	41.38 ± 24.7	8.15 ± 23.8	0.001[a]
D24	2.38 ± 1.9	3.71 ± 1.1	0.50 ± 1.0	<0.001[a]
D25	2.46 ± 2.0	3.86 ± 1.2	0.50 ± 1.0	<0.001[a]
womac	42.74 ± 24.6	41.00 ± 25.4	43.19 ± 24.9	0.826
womacPAIN	11.62 ± 7.8	12.00 ± 5.4	11.52 ± 8.4	0.878
[a]-significant using Independent *t*-test @<0.05 level.				

The four significant parameters were also tested against the gender of the patients (Supplementary Table 2). Results in this assessment showed that shoulder strength of females who experienced pain in NON shoulder (23.45 ± 11.5) were significantly less than those who did not experience pain at all (42.00 ± 15.8), with p-value 0.005. Although statistically insignificant (p-value 0.187), the same results were seen in the shoulder strength of males with pain in NON shoulder (58.14 ± 21.9) and those without (73.25 ± 23.8). Using Welch's *t*-test, TDASH scores for males were found significant (p-value <0.001), while female scores were insignificant (p-value 0.119). However, for both genders, TDASH scores were profoundly higher with those who experienced shoulder pain (34.91 ± 16.1 for males, and 46.56 ± 29.7 for females) than those who did not experience shoulder pain (0.00 ± 0.0 for males, and 17.93 ± 34.6 for females). D24 and D25 scores were also significantly higher (p-value <0.001) in both males and females with shoulder pain (3.57 ± 1.4 and 3.29 ± 1.3, respectively, in males; 3.86 ± 0.7 and 4.43 ± 0.8, respectively, in females) than those without shoulder pain (0.20 ± 0.4 in males, and 0.80 ± 1.3 in females). It was also notable that D24 and D25 scores in females with shoulder pain was higher than that of the scores of males with shoulder pain.

Aside from the gender, the four parameters were also assessed according to the physical activity of the patients (Supplementary Table 3). TDASH scores were significantly

higher (p-value 0.034) in patients who experienced shoulder pain, with and/or without exercise, 31.32 ± 23.4 and 46.41 ± 24.7, respectively, than those who did not have shoulder pain, 0.00 ± 0.0 and 14.94 ± 31.8, respectively. It is also noticeable that TDASH score in patients with shoulder pain who do not exercise is significantly higher than those who exercise. D24 and D25 scores were also significantly higher (p-value of 0.001 and 0.002, respectively) in patients with shoulder pain who exercise (4.25 ± 1.0 and 4.00 ± 0.8, respectively) than those who do not exercise (3.50 ± 1.1 and 3.80 ± 1.3, respectively).

Lastly, the four parameters were tested against the patient's history of DM or HTN (Supplementary Table 4 and 5). Results in this assessment showed that TDASH scores were significantly higher (p-value 0.028) in patients with shoulder pain, whether or not diagnosed with DM (51.62 ± 20.1 and 38.72 ± 27.3, respectively), than those without shoulder pain (0.00 ± 0.0 for DM patients and 9.96 ± 26.2 for non-DM patients). D24 and D25 scores were also significantly higher (p-value <0.001) in patients with shoulder pain, 3.75 ± 0.5 and 4.50 ± 1.0, respectively, for DM patients, and 3.78 ± 1.3 and 3.56 ± 1.2, respectively for non-DM patients, than in patients without shoulder pain, 0.00 ± 0.0 for DM patients, and 0.56 ± 1.0 for non-DM patients. It is also notable that D25 score is higher for DM patients with shoulder pain than in non-DM patients. D24 and D25 scores were also significantly higher (p-values: 0.002 for D24 and 0.003 for D25) in hypertensive patients (3.80 ± 0.8 and 4.00 ± 1.0, respectively) than in non-hypertensive patients (3.75 ± 1.3 and 3.75 ± 1.4, respectively).

Quadriceps strength and knee pain assessment using different parameters and characteristics

Quadriceps strength in the NON knee was evaluated (Table 4). For patients without knee pain, quadriceps strength in NON knee is higher (54.86 ± 44.6), than those patients who experienced knee pain (29.72 ± 41.6). TDASH scores were also significantly higher (p-value 0.031) in patients without knee pain (42.36 ± 29.5) than in patients experiencing knee pain (19.19 ± 25.2). D24 and D25 scores were also significantly higher (p-values 0.004 and 0.005, respectively) in the patients without knee pain (3.88 ± 0.8 and 4.00 ± 0.9, respectively) than in patients with knee pain (1.63 ± 1.9 and 1.69 ± 2.0, respectively).

Table 4: Assessment of knee pain and quadriceps strength parameters

Variables	Total	Knee pain		p-value
		yes	no	
NON knee	34.12 ± 42.7	29.72 ± 41.6	54.86 ± 44.6	0.160
TDASH	28.78 ± 29.0	19.19 ± 25.2	42.36 ± 29.5	0.031[a]
D24	2.38 ± 1.9	1.63 ± 1.9	3.88 ± 0.8	0.004[b]
D25	2.46 ± 2.0	1.69 ± 2.0	4.00 ± 0.9	0.005[b]
womac	42.74 ± 24.6	42.73 ± 24.7	43.00 ± 32.5	0.988
womacPAIN	11.62 ± 7.8	11.70 ± 7.9	10.00 ± 8.5	0.768

[a]-significant using Independent *t*-test @<0.05 level.
[b]-significant using Welch's *t*-test @<0.05 level.

4. Discussion

The main objective of this study was to determine the effect of shoulder pain to hand grip strength, as well as, the effect of knee pain to quadriceps strength. Hand grip strength was measured in both the affected and unaffected shoulders. Results showed that shoulder pain has a negative effect on the hand grip strength. It was noted by Angst et al. (2010) that hand grip strength is a significant factor in predicting disability in muscle function, bone mineral density, and general disability. Previous studies have documented the effects of the presence of shoulder injuries in its muscle activity (Jaggi and Lambert, 2009; Clisby et al, 2008; Labriola et al, 2005). A study by Antony and Kier (2009) showed similar results with this study, wherein muscle strength decreases when gripping is applied to the shoulder. The present study also assessed the correlation between the hand grip strength and gender-based shoulder pain. Results showed that with shoulder pain, hand grip strength is weak in both genders. Moreover, exercise was found to be an insignificant factor in assessing the effect of shoulder pain on the hand grip strength.

To assess the shoulder pain experienced by the respondents, TDASH scores were calculated. TDASH scores in the present study were significantly higher in patients experiencing pain than those that are not. The disability of the arm, shoulder, and hand (TDASH) questionnaire is used to assess the degree of disability of the respondent. The higher the TDASH score, the greater the disability (IWH, 1997). A previous study confirmed that there is a strong positive correlation between perceived pain intensity and pain-related disability (Garbi et al, 2014). TDASH scores for gender-based shoulder pain were consistent with the previous claim. However, it is also noticeable that female respondents have higher TDASH scores than that of the male respondents. This was further validated by the higher D24 and D25 scores in patients with shoulder pain than those without pain. D24 and D25 were the 24th and 25th questions in the TDASH questionnaire pertaining to the pain experienced by the arm, shoulder and hand. Female respondents also had higher D24 and D25 scores than that of the male respondents. Recent human findings regarding gender differences in experimental pain indicate greater pain sensitivity among females compared with males for most pain modalities (Fillingim et al, 2009). The present study also showed that with or without exercise, TDASH scores were higher in patients with shoulder pain than those without. Data from a recent systematic review suggested that the activity levels of patients experiencing pain are neither associated with, nor predictive of, disability or pain levels (Hendrick et al, 2011). The pain experienced by the respondents may be due to their underlying medical diagnosis (Supplementary Table 1), however it is notable that D24 and D25 scores were significant high in patients experiencing pain and with history of DM, and HTN. A study by Krein, et al (2005) indicated that chronic pain was prevalent in patients with diabetes. Moreover, pain experienced by hypertensive patients are pathophysiological and clinical in nature, and can be assessed as acute or chronic (Sacco et al, 2013). However, since the present study did not evaluate the duration of the shoulder pain experienced by the respondents, further investigation may be done in the succeeding studies.

The present study showed that quadriceps strength was greater in patients without knee injury and pain. The same

correlation was found between the hand grip strength and shoulder pain. This is supported by a longitudinal study done by Glass, et al (2013), wherein quadriceps weakness was associated with an increased risk of worsening of knee pain in patients with osteoarthritis. Further research can be done in discussing this correlation since the respondents of this study was mostly affected by osteoarthritis (Supplementary Table 1).

5. Conclusion

The results of the study showed that shoulder pain weakens hand grip strength, at the same time, knee pain weakens quadriceps strength. This is, however, only significant in shoulders and knees that are not affected by the injury or disease condition. Correlation between hand grip or quadriceps strength, and the other demographics such as BMI, physical activity, medical history were inconclusive. Further investigation between these correlations may be conducted in future studies. Shoulder pain and knee pain were also assessed using different parameters. As hypothesized, TDASH scores, along with D24 and D25 were higher in patients experiencing shoulder pain. However, parameters for knee pain such as womac and womacPAIN were found to be statistically insignificant. Therefore, other knee pain-specific parameters can be used for further investigation.

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