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Original Research Article

SHOULDER MUSCLE STRENGTH IN ADULTS WITH AND WITHOUT SHOULDER PAIN

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ABSTRACT

Background: Shoulder muscle strength assessment is routinely used in assessment of patients with shoulder pain. Isometric strength testing provides an easy and objective method of strength assessment. The study aims to measure shoulder muscle strength in adults with and without shoulder pain.

Materials and Methods: A digital weight scale dynamometer was used to measure isometric strength of various muscle groups in shoulder. 181 patients with shoulder pain and 181 age and gender matched controls were included in the study. The maximum peak force produced during testing was recorded. The strength recorded was normalised with weight of the subject.

Results and Conclusion: The patients with shoulder pain had significantly less muscle strength and antagonist strength ratio as compared to control group. The normative data of muscle strength measured in control group is presented. The analysis shows females have significantly less muscle strength than males and the strength of dominant arm was significantly higher than non dominant arm.

KEY WORDS: Shoulder Strength, Isometric Force, Normalised Muscle Force, Antagonist Strength Ratio.

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INTRODUCTION

Shoulder pain is a common musculoskeletal disorder. Disorders of rotator cuff are the most common cause of shoulder pain and disability [1]. Also measuring shoulder muscle strength is a part of routine assessment of patients with shoulder pain. Measurement of shoulder muscle force is routinely used to find out imbalance, to set therapy goals and evaluate the effect of physiotherapy intervention. The most common and widely used method of assessment of muscle force is manual muscle testing. Manual muscle assessment is a subjective evaluation method and its reliability is limited [2]. The ideal method of isokinetic testing involves large and expensive equipment and is time consuming. In literature various portable devices have been used to measure isometric muscle strength [1-4]. The primary advantage of isometric strength testing is that, with the proper equipment, it is relatively quick and easy to perform which lends itself to testing of large groups of subjects. The primary disadvantage of isometric testing is that the strength values recorded are specific to the point(s) in the range of motion at which the isometric contraction occurred, and strength scores at one position may be poorly correlated with strength scores at other positions [5]. Hence, the position in which the muscle strength is tested is very important. In general, isometric strength testing has been shown to be highly reliable as assessed by reliability coefficients (correlations between 0.85 and 0.99) [6]. Also there is a moderate to strong correlation between isometric strength and dynamic performances specially those which involve large amount of force and explosive power[7]. Therefore, measuring isometric muscle strength provides us with a cheaper, easy and recordable method of strength assessment.

The present study has used a portable digital weight scale dynamometer to find out the isometric muscle strength of shoulder muscles in patients with and without shoulder pain. The study aims to provide normative data for isometric muscle strength of shoulder muscles in Indian population. When using these normative values it is important to remember that comparisons between clinically obtained measurements and normative values are legitimate only if the methods used to test a patient closely resemble those used for obtaining normative values[3].

MATERIALS AND METHODS

The present study included 181 subjects with shoulder pain aged between 30-70 years. 181 age and gender matched subjects without shoulder pain were included. The participants signed a consent form and completed a demographic and pain related questionnaire and isometric muscle strength was measured for all the participants for both the arms. The patients with shoulder pain were assigned to a diagnostic category as per the diagnostic criteria of Juel et al, 2014 [8].

Device: A digital suspension weight scale was modified for measuring muscle strength of various shoulder muscles. One fixed end of the scale was attached with a strap for stabilizing the dynamometer with a fixed point on wall/ couch. A Velcro strap with a metal loop was used to attach to the hook end of the scale. The Velcro strap was attached to the patient.

Protocol of strength testing Joint position: Isometric strength testing is dependent on the joint angle hence various positions as described in literature were used [3].

Duration of Contractions: The available literature indicates that a contraction period with a one-second-transition period and a four to five second plateau should be sufficient to achieve a maximal isometric contraction [9]. The available literature suggests that a one-minute rest period should be sufficient to allow adequate recovery between trials [9].

Repetitions: Edwards et al. used three maximal voluntary contractions in testing the quadriceps since the first contraction was usually “tentative”, while the second and third maximal contractions were usually similar to one another (coefficient of variation = 2.8%) [10]. Zeh et al, reported that the mean of three trials was highly correlated with the first score of the three and concluded that one repetition provides “a reasonably good indicator of the subject’s strength in that position [11]”.

The device was stopped at the maximum force produced. The peak force was measured. The force was recorded in kilograms and converted to Newton. The variability in the force scores was reduced by normalization against body weight. The normalised for is described as the force as a percentage of body weight.

Data Analysis: The mean and standard deviation was calculated for all groups. Paired t test was used to compare difference in strength in dominant and non dominant arm in control group and painful and non painful shoulder in patients. Independent t test was used to compare the strength of males and females in control group and to compare patient and control group. ANOVA was used to compare strength difference across various diagnostic categories and further Tukey’s post hoc analysis was used.

RESULTS

Table 1 presents the normative data for shoulder muscle strength for the 181 subjects without shoulder pain. The normalized force is presented age and gender wise for both dominant and non dominant arm. The results show that there is significant difference in muscle strength of dominant and non dominant arm (Table 2). Also

Table1: Age and Gender wise Mean Strengths of Control Group(Force/Weight %).

			Age										
			30-40		41-50		51-60		61-70		Total		
		Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Total
		N	17	17	28	25	19	27	31	17	95	86	181
Flexion	Dominant	Mean	16.87	15.26	18.56	14.57	17.75	13.57	17.59	12.43	17.78	13.97	15.97
		Std.Dev.	7.73	2.79	5.58	5.84	4.74	4.3	5.56	2.61	5.9	4.42	5.58
	Non-Dominant	Mean	15.03	12.57	16.43	13.52	15.09	11.55	15.52	10.49	15.62	12.12	13.95
		Std.Dev.	7.79	2.68	5.63	6.35	4.06	3.78	5.28	2.61	5.74	4.49	5.47
Extension	Dominant	Mean	19.18	18.26	21.8	17.31	21.18	17.16	20.62	15.44	20.82	17.08	19.04
		Std.Dev.	8.82	3.61	6.96	6.63	5.5	4.45	5.29	3.1	6.65	4.93	6.18
	Non-Dominant	Mean	17.17	15.63	19.54	16.27	18.71	14.49	18.33	13.2	18.56	14.98	16.85
		Std.Dev.	8.49	2.95	6.75	7.35	5.55	4.31	5.28	3.24	6.5	5.16	6.17
Abduction	Dominant	Mean	10.35	10.12	12.66	10.15	11.24	8.66	11.23	8.67	11.5	9.38	10.49
		Std.Dev.	3.81	2.43	4.19	3.99	3.5	2.93	2.48	2.87	3.59	3.26	3.6
	Non-Dominant	Mean	8.87	7.91	10.7	8.77	9.3	7.14	9.31	6.96	9.64	7.73	8.73
		Std.Dev.	4.4	2.03	3.94	3.93	3.53	2.41	2.24	1.97	3.56	2.91	3.4
Adduction	Dominant	Mean	12.6	12.31	15.14	12.29	13.81	10.89	13.59	10.56	13.91	11.51	12.77
		Std.Dev.	3.99	2.85	4.25	4.75	3.78	3.47	3.04	3.17	3.85	3.81	4.01
	Non-Dominant	Mean	10.86	10.13	12.79	10.35	11.52	9.02	11.28	8.75	11.7	9.57	10.69
		Std.Dev.	5.13	2.56	4.18	4.46	3.77	2.79	2.64	2.42	3.94	3.34	3.82
Internal Rotation	Dominant	Mean	15.56	15.75	18.54	15.76	17.46	14.21	17.09	14.2	17.32	14.96	16.2
		Std.Dev.	5.9	2.48	5.88	5.68	5.38	3.44	3.61	3.33	5.24	4.07	4.88
	Non-Dominant	Mean	13.35	13.32	16.16	13.4	15.07	12.05	14.17	11.9	14.79	12.67	13.78
		Std.Dev.	6.54	2.26	5.94	5.4	5.03	3.18	3.31	2.89	5.27	3.85	4.77
External Rotation	Dominant	Mean	11.42	11.65	13.46	10.72	12.03	9.59	12.95	9.52	12.64	10.31	11.53
		Std.Dev.	4.02	1.79	4.52	3.78	3.01	2.69	3.51	2.58	3.91	3.01	3.7
	Non-Dominant	Mean	10.24	9.25	11.71	9.11	10.41	8.21	10.97	8.01	10.94	8.64	9.85
		Std.Dev.	4.91	1.74	4.62	3.62	3.14	2.38	2.83	1.67	3.94	2.65	3.58

Table 2: Difference in Normalised Muscle Strength of Dominant and Non- Dominant Arm in Control Group.

Muscle Action	Dominant		Non- Dominant		t- Value	P value
	Mean	SD	Mean	SD		
Flexion	15.97	5.6	13.95	5.49	15.649	0.00
Extension	19.04	6.2	16.85	6.18	16.796	0.00
Abduction	10.49	3.6	8.73	3.14	16.02	0.00
Adduction	12.77	4.03	10.69	3.83	17.56	0.00
Internal Rotation	16.2	4.87	13.78	4.77	20.779	0.00
External Rotation	11.53	3.71	9.85	3.59	14/13	0.00

Table 3: Difference in Normalised Muscle Strength of Males and Females in Control Group.

Muscle Action	Varient	Males		Females		t- Value	P value
		Mean	SD	Mean	SD		
Flexion	Dominant	17.78	5.93	13.97	4.45	4.916	0.00
	Non-Dominant	15.61	5.77	12.12	4.52	4.566	0.00
Extension	Dominant	20.82	6.68	17.08	4.96	4.305	0.00
	Non-Dominant	18.56	6.53	14.98	5.19	4.098	0.00
Abduction	Dominant	11.5	3.61	9.38	3.28	4.103	0.00
	Non-Dominant	9.64	3.58	7.73	2.92	3.906	0.00
Adduction	Dominant	13.91	3.87	11.51	3.83	4.18	0.00
	Non-Dominant	11.7	3.96	9.57	3.36	3.871	0.00
Internal Rotation	Dominant	17.32	5.23	14.96	4.13	3.342	0.00
	Non-Dominant	14.79	5.3	12.67	3.87	3.054	0.003
External Rotation	Dominant	12.64	3.93	10.31	3.03	4.437	0.00
	Non-Dominant	10.94	3.96	8.63	2.66	4.632	0.00

Table 4: Comparison of Normalised Muscle Strength of Painful and Non Painful Shoulder in Individuals with Unilateral Shoulder Pain.

Muscle Action	Painful		Non- Painful		t- Value	P value
	Mean	SD	Mean	SD		
Flexion	13.58	7.35	17.01	7.16	-10.4	0.00
Extension	17.73	8.95	20.04	7.99	-7.051	0.00
Abduction	8.24	5	11.23	6.26	-10.37	0.00
Adduction	11.21	6.07	14.62	8.09	-10.835	0.00
Internal Rotation	12.07	5.73	15.03	5.9	-10.058	0.00
External Rotation	7.34	3.16	10.34	3.9	-12.692	0.00

Table 5: Comparison of Normalised Muscle Strength and Antagonist Strength Ratios Between two Groups.

	Subjects without (n=181)		Subjects with (n=181)			
	Mean	SD	Mean	SD	t- value	p value
Flexion	15.9694	5.59764	14.5492	7.57899	2.028	0.043
Extension	19.0448	6.19949	18.3988	8.79537	0.808	0.42
Abduction	10.4925	3.6097	8.4933	4.87085	4.436	0.00
Adduction	12.7723	4.02572	11.7885	6.23899	1.783	0.075
Internal Rotation	16.1984	4.87215	12.8374	5.92828	5.893	0.00
External Rotation	11.5331	3.7119	7.7924	3.47482	9.898	0.00
Flexion/Extension	0.84	0.1	0.79	0.15	3.213	0.00
Abduction/Adduction	0.82	0.09	0.73	0.17	6.169	0.00
External/Internal Rotation	0.71	0.09	0.63	0.18	5.67	0.001

Table 6: Antagonist Strength Ratios for Various Diagnostic Categories of Shoulder Pain.

		Flexion/Extension		Abduction/Adduction		External/Internal Rotation	
Diagnosis	N	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
No	24	0.82	0.12	0.69	0.21	0.59	0.17
Subacromial PainSyndrome	62	0.82	0.15	0.72	0.16	0.71	0.37
Myalgia	22	0.83	0.11	0.76	0.22	0.69	0.15
Adhesive Capsulitis	42	0.74	0.21	0.81	0.11	0.65	0.18
Rotator Cuff Tear	15	0.53	0.24	0.57	0.09	0.58	0.33
Total	165	0.78	0.19	0.73	0.17	0.66	0.28
F		10.813		7.198		1.214	
p value		0.00		0.00		0.307	

males have significantly higher muscle strength than females (Table 3). On comparison of the subjects with shoulder pain Table 4 shows significantly reduced muscle strength in painful side as compared to non painful side. On comparison of the subjects with shoulder pain with those without pain significant difference is seen in all muscle groups except shoulder extension and adduction (Table 5). The antagonist strength ratios of shoulder muscles were also compared between the patients with and without shoulder pain. Table 5 shows that the antagonist strength ratios are significantly reduced in those with shoulder pain compared to control group. Further the patients were categorised to various diagnostic categories. Majority of patients were assigned to 5 main diagnostic categories (n=165). The antagonist strength ratios differ significantly across various diagnostic categories (table 6). On further analysis it was seen that the flexion/extension strength ratio differed significantly for patients with rotator cuff tear as compared to all other 4 diagnostic categories. On analysis of abduction/adduction strength ratios it was seen that the patients with rotator cuff tear had minimum value for the abduction/adduction ratio which was significantly lower than that of patients with subacromial pain syndrome, myalgia and adhesive capsulitis. The abduction /adduction strength ratio was highest for patients with adhesive capsulitis. Interestingly external/ internal rotation strength ratio did not differ significantly across various diagnostic categories (Table 6).

DISCUSSION

The mean normalised strength of various shoulder muscle groups in normal subjects ranges from 8 to 17 percent. This is very less as compared to normalised strength reported by previous authors [3,4]. However, the relationship of strength in antagonist muscles is similar as reported by previous studies with mean extension force more than mean flexion force. Also mean internal rotation force is greater than medial rotation. The difference in peak force as compared to previous studies may be due to difference in devices used for measuring isometric strength and the difference in race and ethnicity. The results show that the strength of dominant arm is more than the non dominant arm. Stoll et al 2000, also found that strength of right arm was more than left arm [12]. However, Murray et al found that arm dominance did not affect strength values [13].

Males had significantly greater strength than females. Our results are similar to those reported by previous studies. This may be attributed to physiological difference in muscle mass in males and females. Lean woman muscle mass is about 30% of total body weight, whereas in a lean man it is 40-45% [12]. The gender differences in muscle strength may be mainly due to difference in size of muscle fibres.

The analysis of the muscle strength of subjects with shoulder pain shows that there is significant difference in muscle strength of painful and non painful side. This may be due to inhibition of muscles due to pain or involvement of muscles in various pathologies [14]. Involvement of rotator cuff in shoulder tendinitis or partial or complete tear may lead to reduced strength. Also, the strength differ significantly between those with and without shoulder pain. The difference is not seen in strength of shoulder extension and shoulder adduction. This may be due to reason that shoulder flexors and abductors are the main muscle groups involved in tendinitis and other pathologies.

The comparisons of antagonist strength ratios across various diagnostic categories reveal that the antagonist strength ratio of flexion/ extension and abduction/adduction is significantly reduced in patients with rotator cuff tear as compared to other diagnosis. However, no significant difference was seen for external/ internal rotation strength ratio across various diagnostic categories. The results bring out the need for further study with larger sample size to study the difference in antagonist strength ratios across various diagnosis for shoulder pain.

CONCLUSION

The patients with shoulder pain had significantly less strength and antagonist strength ratios as compared to control group. In the normal subjects the strength was significantly less in females as compared to males. The strength in non dominant arm was significantly less than dominant arm.

Conflicts of interest: None

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