Journal of Sports Science and Physical Education, Malaysia ISSN: 2232- 1926
http://jsspj.upsi.edu.my/

Research article

THE EFFECTS OF FOREARM POSITION ON HANDGRIP STRENGTH

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Abstract

Journal of Sports Science and Physical Education 2(1): 2-8, 2013 - This study was conducted to investigate i) while the shoulder was in 180° of flexion and the elbow extended, which of the forearm position (supination, pronation and neutral) can generate the greatest handgrip strength, ii) is there any correlation of the handgrip strength between the dominant hand (right hand) and non-dominant hand (left hand) in each forearm position, and iii) will the dominant hand possessed 10% higher handgrip strength than the non-dominant hand. 100 right handed sedentary active students age 22.20 years old (± 1.03), height 172.83 cm (± 6.37), body mass 68.87 (± 11.52) and grip position 3.77 (± 0.77) were recruited in this study. The result indicated that for both the dominant and non-dominant hand, when the shoulder is in 180˚ flexion of the body with the elbow extended, the greatest grip strength was obtained when the forearm was in neutral position followed by pronation and supination position. Post Hoc analysis showed that for both dominant hand and non-dominant hand, pronation and supination forearm position produced greater strength score compared to supination forearm position ($p<0.05$). No significant different were found comparing pronation and neutral forearm position ($p>0.05$). In all forearm position, participants were shown to produced significantly greater strength in their dominant hand and all the scores were more than 10% greater compared to when using non-dominant hand. Positive relationships were also found for the strength score between dominant hand and non-dominant hand. As the conclusion, different shoulder, elbow and forearm position can affect handgrip strength.

Keywords: handgrip strength, supination, pronation, neutral, dominant hand, non-dominant hand

Introduction

People are generally limited by their strength when exerting force. Handgrip strength is an important component of many sports and activities. In sport or athletics situations, a weak grip could result in a missed tackle in american football and rugby, slipping of grip of javelin, or the inability to perform certain techniques or maneuvers on various gymnastics apparatus like the rings or bars. In activities like arm wrestling, strongman, and martial arts, a strong grip is an absolute requirement. Many sports require good grip strength, in particular the sports that involve the holding or swinging of an implement such as baseball bat, hockey stick, and tennis racquet. Grip strength is also important in the throwing or catching of a ball such as in baseball and football, or the grabbing, holding or tackling of an opponent such as in judo and rugby.

Handgrip strength refers to the maximal isometric force that can be mainly generated by the hand and forearm muscles. According to Shea (2007) many daily functions and sporting events require high activity levels of the flexor musculature of the forearms and hands. These are the muscles that involved in gripping. Shea (2007) stated that there are 35 muscles involved in the movement of the hand and the forehand. Many of these muscles involved in gripping activities. The flexor muscles in the the hand and the forearm will create the grip strength while the extensor muscles in the forearm will stabilize the wrist during gripping activities (Waldo, 1996).

Handheld dynamometer has been one of the most common method of assessment for grip strength (Febrer, Rodriguez, Alias, & Tizzano, 2010; Wind, Takken, Helders, & Engelbert, 2010). Grip strength testing using handheld dynamometer is a form of biomechanical measurement that allow sports coaches to know the bioenergetics and efficiency of sports movements. Handheld grip strength dynamometer is used to measure the muscular force generated by the hand and forearm's flexor mechanism (Mijnarends et al., 2013; Thorborg, Petersen, Magnusson, & Hölmich, 2010).

In an attempt to establish more rigorous grip strength testing procedures, there had been researches that shown the effects of different body posture, forearm position and many more on grip strength (España-Romero et al., 2010). Grip strength is reported to be higher in dominant hand with right handed subjects (Koley & Singh, 2010). Therapists often use the 10% rule as a general guideline for the goal setting for their patients. The 10% rule states that a dominant hand can generate 10% greater handgrip strength compared to the non-dominant hand (Bechtol, 1954; Roberts et al., 2011). The 10% rule dates back to 1954, when (Bechtol, 1954) observed that most of his subjects that consisted of hospital patients had a difference of 5% to 10% between their dominant and non-dominant hands on handgrip measurements where the dominant hand was stronger.

As an alternative to improve the knowledge on the effects of forearm position on handgrip stregth, this study was conducted to investigate *i)* while the shoulder was in 180° of flexion and the elbow extended, which of the forearm position (supination, pronation and neutral) can generate the greatest handgrip strength, *ii)* is there any correlation of the handgrip strength between the dominant hand (right hand) and non-dominant hand (left hand) in each forearm position, and *iii)* will the dominant hand possessed 10% higher handgrip strength than the non-dominant hand.

Methodology

Participants

This research involved 100 active sedentary students who are right handed. Participants had no medical problems and not consuming any performance enhancing supplementation. Participants were screened prior to testing using PAR Q. Each participant had read and signed an informed consent for testing

Instrumentation

Handgrip strength test

Takei A5401 hand grip dynamometer digital has been used to measure the forearm static strength. It can be adjusted to fit a wide range of hand sizes and normative grip values are available from ages 10 to 70. It had a measurement range of 5 to 100 kg and it's minimum measurement unit is 0.1 kg.

Handgrip strength testing procedure

The following steps were taken to measure handgrip strength.

i. Participant should be in the standing position.
ii. Participant's head should be in the midposition (facing straight ahead).
iii. The grip size should be adjusted so that the middle finger's (third digit's) midportion (second phalanx) is approximately at a right angle.
iv. Participant's shoulders placed at 180˚ of flexion with the elbows extended.
v. Participants performed the test with the forearm in supination.
vi. Participants made three trials, 2 minutes between trials.
vii. The handgrip strength score of the participant was recorded in kg.
viii. The instructor resets the dynamometer's pointer to zero after each trial.
ix. Participants performed 3 times of trials for each of hand and data was collected.
x. The score of the subjects is taken from the highest score of the trials.
xi. Participants performed all three forearm position in randomized order to prevent order effects.

Data Analysis

Descriptive analysis was conducted to determine the mean data of participants' physical characteristics and handgrip strength score. One-Way Analysis of Variance (ANOVA) was conducted to compare the handgrip strength between all forearm positions. Paired t-test was conducted to compare the handgrip strength score between dominant and non-dominant hand. Lastly, Pearson correlation was conducted to analyze the relationship between handgrip strength score in dominant and non-dominant hand. All statistical analysis was conducted using SPSS version 19 (IBM, USA).

Results

Table 1: Descriptive analysis of the subjects

	Mean	Std. Deviation
Age	22.20	1.03
Height	172.83	6.37
Body Mass	68.87	11.52
Position	3.77	0.77

Table 1 showed the mean (± SD) for age 22.20 years old (± 1.03), height 172.83 cm (± 6.37), body mass 68.87 (± 11.52) and grip position 3.77 (± 0.77).

Table 2 showed the mean (± SD) of strength score for right forearm supination (RFS), 37.02 (± 7.02), right forearm neutral (RFN), 45.83 (± 4.63), right forearm pronation (RFP), 43.23 (± 6.41). Post Hoc analysis showed that for dominant hand, RFP and RFN produced significantly greater handgrip strength compared to RFS. No significant different were found comparing RFP and RFN. Table 3 showed the mean (± SD) of strength score for left forearm supination (LFS), 31.26 (± 8.41), left forearm neutral (LFN), 40.49 (± 4.49) and left forearm pronation (LFP), 38.09 (± 6.73). Like the dominant hand, Post Hoc analysis showed that for non-dominant hand, LFP and LFN produced significantly greater handgrip strength compared to LFS. No significant different were found comparing LFP and LFN.

Table 2: Handgrip strength score of the dominant hand

	Mean	SD
RFS	37.02[bc]	7.02
RFN	45.83[a]	4.63
RFP	43.23[a]	6.41

[a] = significantly different from RFS
[b] = significantly different from RFN
[c] = significantly different from RFP

Table 3: Handgrip strength score of the non-dominant hand

	Mean	SD
LFS	31.26[bc]	8.41
LFN	40.49[a]	4.49
LFP	38.09[a]	6.73

[a] = significantly different from LFS
[b] = significantly different from LFN
[c] = significantly different from LFP

Pearson Correlation analysis (Table 4) demonstrated positive correlation existed between dominant and non-dominant hand in all forearm position. Participants who scored higher using right hand were shown also scored higher using left hand in all forearm position.

Table 4: Correlation analysis of right and left hand strength score

	r	p
RFS-LFS	.932	.000
RFN-LFN	.852	.000
RFP-LFP	.831	.000

Table 5 showed the comparison of handgrip score between right and left hand in each forearm position. Paired t-test analysis showed that for all forearm position, participants scored higher using their right hand (dominant hand).

Table 5: Differences of handgrip strength between dominant and non-dominant hand

	Mean differences (M ± SD)	% differences (M ± SD)	p
RFS-LFS	5.76 ± 3.04	15.56 ± 4.94	0.00
RFN-LFN	5.24 ± 2.36	11.65 ± 3.87	0.00
RFP-LFP	5.14 ± 2.10	11.89 ± 3.95	0.00

Results showed using supination forearm position, dominant hand possessed 15.56% higher grip strength than non-dominant hand. Using neutral forearm position, dominant hand possessed 11.65% higher grip strength than non-dominant hand. Lastly, using pronation forearm position, dominant hand possessed 11.89% higher grip strength than non-dominant hand.

Discussion

The major findings of this study were that when the shoulder was in 180˚ flexion and elbow was fully extended, handgrip strength were significantly greater in pronation and neutral foream position compared to the supination forearm position both in the dominant and non-dominant hand. Other than that, results also showed that there was significant correlation of handgrip strength between the dominant and non-dominant hand by each forearm position. One more finding is that the results showed that there was significant different in handgrip strength between the dominant and non-dominant hand. All the forearm position in dominant hand produced more than 10% greater strength compared to the non-dominant hand.

On the basis of the potential changes in the length-tension relationships that may occur as the cause of changing the forearm from supination to pronation, one would predict a weaker grip in the pronated position than in the supinated position. The change in length of the long flexor muscles from supination to pronation also potentially changes the synergistic relationships among the long extensors of the fingers and the flexor and extensor muscles that stabilize the wrist joint. The potential result is a decreased ability to stabilize the wrist, which could lead to decreased grip strength (Richards, Olson, & Palmiter-Thomas, 1996).

Our finding that the strongest grip strengths occured when the forearm was in pronation for the right hand and neutral for the left hand was not in line with (Richards et al., 1996) but it must be taken into consideration that this contradiction occured as the result of changing the shoulder position from 0˚ to 180˚ and the changing of elbow from 90˚ to fully extended. Based on study by Su, Lin, Chien, Cheng, and Sung (1994) that the strongest grips were obtained while the shoulder was in 180° of flexion and the elbow extended, this research is done to investigate which of the forearm position while the shoulder was in 180° of flexion and the elbow extended can generate the greatest strength or force.

The current findings showed that when the shoulder was in 180˚ with elbow extended, the strongest grip happened when the forearm is in neutral position, followed by pronation and supination in both the dominant and non-dominant hand. One of the possibilities for this result to occur might be due to the unfamiliarity among the participants to perform any activities in supination forearm position when the shoulder was 180˚ flexed.

Another finding in this study was that significant correlation of the handgrip strength was found between the dominant and non-dominant hand in each forearm position. This was in line with what has been found by Watters, Haffejee, Angorn, and Duffy (1985) suggested that participants had less imbalance of strength between the dominant and the non-dominant hand. High correlation of handgrip strength in all forearm grips showed that as the subjects' grip strength in dominant hand increases, the grip strength in the non-dominant hand also increases. Looking at the correlation value, it was found that the correlation was highest when the forearm position is in supination position. This means that subjects had greater balance of force production when performing some activities involving supination grip compared to the neutral and pronation grip.

Additionally, in this study we also want to find out whether is there significant difference of handgrip strength between the dominant and non-dominant hand. The results for the strength of the different hand are rather obvious with the dominant hand obtained greater grip strength than the non-dominant hand. The utility of the 10% rule when the hand is in the stated position was also tested. The 10% rule states that the dominant hand possesses 10% greater grip strength than the non-dominant hand (Bechtol, 1954).

As presented in table 5, results showed using supination forearm position, dominant hand possessed 15.56% higher grip strength than non-dominant hand. Using neutral forearm position, dominant hand possessed 11.65% higher grip strength than non-dominant hand. Lastly, using pronation forearm position, dominant hand possessed 11.89% higher grip strength than non-dominant hand. This finding thus was in line with the 10% rule in which dominant hand possessed 10% greater strength compared to non-dominant hand (Bechtol, 1954).

The significant different that existed might be due to the participants that always did most of their daily activities with the dominant hand. As the usage of the dominant hand increases, the muscles in the dominant hand will be trained better than the muscles in the non-dominant hand. The differences in the handgrip strength between the dominant and non-dominant hand could also be due to several physiological reasons. Several researchers reported differences in the physiology between the dominant and the non-dominant upper limb. A higher percentage of type I muscle fibers was found in the extensor carpi radialis brevis of the dominant arm compared with the homologous muscle of the contralateral arm (Fugl-Meyer, Eriksson, Sjöström, & Söderström, 1982).

Conclusion

This study showed that the changes of forearm position do have effects on handgrip strength. Besides that, this study agreed with the 10% rule in which dominant hand possessed 10% greater strength compared to non-dominant hand.

References

Bechtol, C. (1954). Grip teat; the use of a dynamometer with adjustable handle spacings. *J Bone Joint Surg Am, 36-A*(4), 820-824.

España-Romero, V., Ortega, F. B., Vicente-Rodríguez, G., Artero, E. G., Rey, J. P., & Ruiz, J. R. (2010). Elbow position affects handgrip strength in adolescents: validity and reliability of Jamar, DynEx, and TKK dynamometers. *The Journal of Strength & Conditioning Research, 24*(1), 272-277.

Febrer, A., Rodriguez, N., Alias, L., & Tizzano, E. (2010). Measurement of muscle strength with a handheld dynamometer in patients with chronic spinal muscular atrophy. *Journal of rehabilitation medicine, 42*(3), 228-231.

Fugl-Meyer, A. R., Eriksson, A., Sjöström, M., & Söderström, G. (1982). Is muscle structure influenced by genetical or functional factors? A study of three forearm muscles. *Acta physiologica scandinavica, 114*(2), 277-281.

Koley, S., & Singh, A. P. (2010). Effect of hand dominance in grip strength in collegiate population of Amritsar, Punjab, India. *Anthropologist, 12*(1), 13-16.

Mijnarends, D. M., Meijers, J. M., Halfens, R. J., ter Borg, S., Luiking, Y. C., Verlaan, S., . . . Schols, J. M. (2013). Validity and reliability of tools to measure muscle mass, strength, and physical performance in community-dwelling older people: a systematic review. *Journal of the American Medical Directors Association, 14*(3), 170-178.

Richards, L. G., Olson, B., & Palmiter-Thomas, P. (1996). How forearm position affects grip strength. *American Journal of Occupational Therapy, 50*(2), 133-138.

Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age and ageing*, afr051.

Shea, J. (2007). PES; The Importance Of Grip Strength. *Journal of Strength and Conditioning Research, 21*(3), 923-929.

Su, C.-Y., Lin, J.-L., Chien, T.-H., Cheng, K.-F., & Sung, Y.-T. (1994). Grip strength in different positions of elbow and shoulder. *Archives of physical medicine and rehabilitation, 75*(7), 812-815.

Thorborg, K., Petersen, J., Magnusson, S., & Hölmich, P. (2010). Clinical assessment of hip strength using a hand-held dynamometer is reliable. *Scandinavian journal of medicine & science in sports, 20*(3), 493-501.

Waldo, B. R. (1996). Grip Strength Testing. *Strength & Conditioning Journal, 18*(5), 32-35.

Watters, D., Haffejee, A., Angorn, I., & Duffy, K. (1985). Nutritional assessment by hand grip dynamometry. *S Afr Med J, 68*(8), 585-587.

Wind, A. E., Takken, T., Helders, P. J., & Engelbert, R. H. (2010). Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? *European journal of pediatrics, 169*(3), 281-287.

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