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# The Characteristics of Grip Force of Judoists

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【Introduction】

The strength of gripping objects, that is, grip force is almost always necessary to play various kinds of athletics regardless of its strength. [1),2),4)-6),8)] In the case of judo, the grip force of judoists are necessary to Throwing technique, Holding technique, Ground technique, Squeezing technique and Disjoint technique as well as to protect against those techniques. [8),15)-17),25),26)]

Various studies have been reported in terms of grip force of judoists, such as the analysis of the way of gripping of judo from the point of view of finger force by Takeuchi. *et al.* [26)], the structure of the movement of Throwing Technique on the basis of judoist's grip force by Matsunaga. *et al.* [15),17)], the durability of maximum holding power of judoists by Ishikuro. *et al.*, and instantaneous grip force of judoists etc by Takeuchi. *et al.* [25)].

Ono [19)] mentioned that there were both positive manner and negative manner in the structure of static muscle contraction. Based on his remark, there are studies that subjects are both university students who belong to various kind of athletic clubs carried out by Furuya. *et al.* [1)] and that subjects who are elementary school students by Komata. *et al.* [10)]. Further more, Kaisei. *et al.* [8)] and Sato. *et al.* [20)] reported about the manner of judoists. However, muscular force of both leg and trunk affects the measurement of negative grip force to no small extent. For this reason, this study tried to measure pure grip force. In this research, positive grip force is stated as the force to grip an object with his/her palm and five fingers triggered by his/her intention. On the other hand, negative grip force is the grip force against external pressure to release his/her grasp, which was held by mainly the second finger and the fifth finger. The former is generally measured as the grip strength of the muscle force, and the latter is represented as handgrip of strap or horizontal bar. It can be said that there is no dispute against clear differences between them.

This study tried to clarify the characteristics of grip force of judoists such as how much judoists can perform negative grip force that is important factor of grip for Judo, how positive grip force relate to negative grip force, which grip force can perform stronger in practice even though Hanging Action is thought to be more important than Pulling Action in general and negative grip force is used more often[1)-14),17),18),22),27)], and which bending of wrist joint, full bending or half bending can grip stronger.

【Methods】

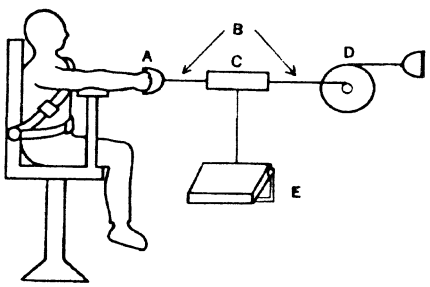
Twenty university students (male) who belong to judo club were tested in this study. Characters

of Subjects are Age is 20.4±1.1(Mean ± S.D.) years old, height is 174.1±5.7cm, weight is 86.4 ±9.8kg and Judo career is 8.6±2yeares. Nine were judo grade of the third "dan" and eleven were second "dan".

The equipment used with this experiment is shown in Figure 1. Subject grips grip *A*, which is connected to combination pulley *D* by wire *B*, and pulls. Digital muscle strength meter *C* is connected in the middle of wire and maximum muscle force is measured by digital dynamometer *E* which indicates negative grip force.

In practice, each subject was seated on a multi-purpose muscle strength measuring machine and gripped the grip under the conditions of formed 90° flexion of his shoulder joint and extension of his cubital joint. The grip *A* has a thickness of 2.64 centimeter.[3] In order to avoid the strength of both his legs and the turning movement of his shoulders, the height of seat was adjusted to separate his both feet from the floor. His shoulders and waist were tightened respectively with belts placed at the equipment. Simply his grip force was performed according to the settlement.

An examiner set up the wire that muscle strength meter points zero and pulled it at 3 cm/sec. The maximum muscle strength was measured until the subject releases his hand from the grip according to the unendurable stress by the examiner.




A:Grip　B:Wire　C:Muscle strength meter
D:Pulley　E:Digital dynamometer

**Figure 1** Layout of the equipment

The grip force was measured by extending forearm and wrist forward at an intermediate shoulder position, hereinafter referred to as *negative grip force A*, and by flexing wrist joint to the maximum of its range of movement at the same position of forearm, hereinafter referred to as *negative grip force B*. Each grip force was measured in two cases, that is, deep grip that flexes the third finger joint and shallow grip that flexes the second finger joint. Namely, four kinds of negative grip force were measured at each hand.

The examination was carried out by a few subjects. Interval amongst each test was more than 15 minutes in order to avoid the effect of their fatigues.

Grip meter (Smedley type) was used for measuring the positive grip force in the same way as physical test. Both positive grip force and negative grip force were measured twice at each hand and larger strength of each grip force was adopted as a record.

In the statistical consideration, the factor of gripping methods which were the relation between hanging action and pulling action, were considered as the results regardless of dominant hand or not. t-test was done with dependant two specimens within individual comparison and correlation coefficient was calculated. Significance level was less than 5%.

【Results】

t-tests were computed to compare the grip force in hanging action and pulling action (Table 1 and Table 2). Gripping method was applied to 13 participants and left gripping method to 7 amongst 20 participants. In case of right gripping method, hanging action was performed by their right had and pulling action was done by their left hand. On the other hand, it was the opposite in case of left

**Table 1** Comparison of grip force between hanging and pull action (Negative Force A)

n=20

| | Positive Force (kg) | Deep Grip | | Shallow Grip | |
|---|---|---|---|---|---|
| | | Negative Force A (kg) | Negative Force A / Positive Force (%) | Negative Force A (kg) | Negative Force A / Positive Force (%) |
| Hanging Action | 56.0 | 106.2 | 189.8 | 91.3 | 165.3 |
| S.D. | 4.7 | 9.8 | 15.2 | 6.9 | 13.6 |
| Pulling Action | 54.7 | 100.7 | 184.2 | 90.0 | 164.7 |
| S.D. | 3.9 | 7.9 | 13.6 | 7.2 | 14.1 |
| diff | 1.3 | 5.5 | 5.6 | 1.3 | 0.6 |
| t-test | n.s. | P<0.01 | n.s. | n.s. | n.s. |

diff : Hanging − Pulling
n.s.: not significant

**Table 2** Comparison of grip force between hanging and pulling action (Negative Force B)

n=20

| | Positive Force (kg) | Deep Grip | | Shallow Grip | |
|---|---|---|---|---|---|
| | | Negative Force B (kg) | Negative Force B / Positive Force (%) | Negative Force B (kg) | Negative Force B / Positive Force (%) |
| Hanging Action | 56.0 | 110.0 | 196.2 | 98.9 | 175.8 |
| S.D. | 4.7 | 10.1 | 16.1 | 6.8 | 12.9 |
| Pulling Action | 54.7 | 104.5 | 190.7 | 95.7 | 178.5 |
| S.D. | 3.9 | 8.7 | 14.8 | 7.4 | 15.2 |
| diff | 1.3 | 5.5 | 5.5 | 3.2 | −2.7 |
| t-test | n.s. | P<0.01 | n.s. | n.s. | n.s. |

diff : Hanging − Pulling
n.s.: not significant

griping method.

Positive grip force indicates 56.0±4.7kg in hanging action and 54.7±3.9kg in pulling action(n.s.). There is no significant difference between them.

In case of negative grip force A, 106.2±9.8kg was indicated in hanging action and 100.7±7.9kg in pulling action at deep grip($p < 0.01$). At shallow grip of that case, 91.3±6.9kg in hanging action and 90.0±7.2kg in pulling action. In case of negative grip force B, hanging action indicated 110.0±10.1kg and 104.5±8.7kg in pulling action at deep grip ($p < 0.01$). On the other hand, 98.9±6.8kg in hanging action and 95.7±7.4kg in pulling action at shallow grip(n.s.). One percent significant difference was shown in both negative grip force A and B.

Looking at the ratio of those negative grip forces in positive grip forces, hanging action was 189.8±15.2% and pulling action was 184.2±13.6% in case of negative grip force A at deep grip(n.s.). At shallow grip of that case, 165.3±13.6% to hanging action and 164.7±14.1% to pulling action(n.s.).

In case of negative grip force B, hanging action was 196.2±16.1% and pulling action was 190.7±14.8% at deep grip(n.s.). In its shallow case,

Table 3 Relation between positive and negative grip force

n=20

| | | Negative Force A | | Negative Force B | |
|---|---|---|---|---|---|
| | | Deep Grip | Shallow Grip | Deep Grip | Shallow Grip |
| Positive Force | Hanging Action | 0.45* | 0.50* | 0.54* | 0.35 |
| | Pulling Action | 0.45* | 0.55* | 0.55* | 0.39 |

* : P<0.05

Table 4 Relation between positive grip force and the proportion of negative grip force used in the positive grip force

n=20

| | | Negative Force A / Positive Force | | Negative Force B / Positive Force | |
|---|---|---|---|---|---|
| | | Deep Grip | Shallow Grip | Deep Grip | Shallow Grip |
| Positive Force | Hanging Action | −0.22 | −0.28 | −0.11 | −0.26 |
| | Pulling Action | −0.07 | −0.06 | −0.08 | −0.20 |

hanging action was 175.8±12.9% and pulling action was 178.5±15.2% (n. s.).

There is no significant difference in both negative grip force A and B against positive grip force at all grip patterns.

Correlation analyses were done in order to examine the relationship between positive grip force and negative grip force. (Table 3)

The results showed that positive grip force and negative grip force A in hanging action was positively correlated in the deep grip ($r=0.45$, $p<0.05$) and in the shallow grip ($r=0.50$, $p<0.05$). In pulling action, the correlation was also significant in the deep grip ($r=0.45$, $p<0.05$) and in the shallow grip ($r=0.55$, $p<0.05$).

In case of negative force B, the correlation in hanging action was significant in the deep grip ($r=0.54$, $p<0.05$), but not in the shallow grip ($r=0.35$, n. s.). Likewise, the correlation in the pulling action was significant in the deep grip ($r=0.55$, $p<0.05$), but not in the shallow grip ($r=0.39$, n. s.).

To examine how negative grip force relates to the degree of positive grip force, correlation between positive grip force and the ratio of negative grip force in positive grip force was calculated. (Table 4)

There was no significance amongst all eight griping patterns in the correlation between positive grip force and the ratio of negative grip force in positive grip force.

Next t-test were computed to compare negative grip force A and negative grip force B (Table 5 and 6). In case of deep grip in hanging action, negative grip force A was 106.2±9.8kg and B was 110.0±10.1kg ($p<0.05$). On the other hand, negative grip force A was 91.3±6.9kg and B was 98.9±6.8kg ($p<0.01$) in case of shallow grip at the action. In case of pulling action deep grip, negative grip force A was 100.7±7.9kg and B was 104.5±8.7kg ($p<0.05$). On the other hand, negative grip force A was 90.0±7.2kg and B was 95.7±7.4kg ($p<0.05$) in case of shallow grip at the action. There are significances amongst all four griping patterns.

**Table 5** Comparison between negative grip A and B

n=20

| | Deep Grip | | Shallow Grip | |
|---|---|---|---|---|
| | Hanging Action | Pulling Action | Hanging Action | Pulling Action |
| Negative Force A (kg) | 106.2 | 100.7 | 91.3 | 90.0 |
| S.D. | 9.8 | 7.9 | 6.9 | 7.2 |
| Negative Force B (kg) | 110.0 | 104.5 | 98.9 | 95.7 |
| S.D. | 10.1 | 8.7 | 6.8 | 7.4 |
| diff (kg) | −3.8 | −3.8 | −7.6 | −5.7 |
| t-test | P<0.05 | P<0.05 | P<0.01 | P<0.05 |

diff : Negative A − Negative B

The comparison the ratios of those negative grip forces in positive grip force showed that in case of deep grip in hanging action, negative grip force A showed 189.8±15.2% and showed 196.2±16.1% (n. s.). In the case of shallow grip, negative grip force A showed 165.3±13.6% and B showed 175.8±12.9% ($p<0.05$).

Table 6 Comparison between negative grip A and B (the proportion of negative grip force used in the positive grip force)

n=20

| | Deep Grip | | Shallow Grip | |
|---|---|---|---|---|
| | Hanging Action | Pulling Action | Hanging Action | Pulling Action |
| Negative ForceA / Positive Force (%) | 189.8 | 184.2 | 165.3 | 164.7 |
| S.D. | 15.2 | 13.6 | 13.6 | 14.1 |
| Negative ForceB / Positive Force (%) | 196.2 | 190.7 | 175.8 | 178.5 |
| S.D. | 16.1 | 14.8 | 12.9 | 15.2 |
| diff (%) | -6.4 | -6.5 | -10.5 | -13.8 |
| t-test | n.s. | n.s. | P<0.05 | P<0.01 |

diff : Negative A - Negative B
n.s. : not significant

In cases of pulling action, negative grip force A showed 184.2±13.6% and B showed 190.7±14.8 (n.s.) at deep grip. In the shallow grip, negative grip force A showed 164.7±14.1% and B showed 178.5±15.2% ($p < 0.01$). Only the case of shallow grip shows significance in both hanging action and pulling action.

【Discussion】

The characteristics of grip force, which was important factor for judoists, were clarified by measuring both positive grip force and negative grip force in this study.

In both hanging action and pulling action, significant differences were not found for positive grip force, however negative grip force A and B in hanging action was greater than those in pulling action only at the deep grip condition. Kaise. *et al.* [8] and Sato. *et al.* [20] reported that there was no significance diferencs between hanging action and pulling action in both positive grip force and negative grip force. These findings could be reflected by some different measuring position such as different equipment developed for measuring negative grip force as well as the different testing form of subjects, that is, 100° flexion of cubital joint at intermediate shoulder level position in case of Kaise. *et al.* [8] and extension of cubital joint at inward rotation of forearm in case of Sato. *et al.* [20] These articles should also involve the factors of muscle of both legs and trunk at least.

At the moment that *tori* playing throwing technique, *uke* makes a stand against the throwing by way of shifting his weight to his backward or tries to cut *tori*'s hand of pulling action. In this case, hanging action of both *tori* and *uke* performs negative grip force at deep grip and on the other hand, pulling action of both *tori* and *uke* performs negative grip force at shallow grip. Also, in case of hanging action, it is quite easy to grip deeply due to the shape of judogi and its gripping position. In case of pulling action, however, it is very difficult to grip deeply because of the movement of his/her opponent, little space between opponent's arm and judogi and conflicting opponent's gripping method due to the different dominant hand.

Namely, it is thought that the tendency of using deep grip in hanging action and using shallow grip pulling action affects the results in any way.

The analyses with the ratio of negative grip force in positive grip force did not show any significant results, which indicated that there was no difference of the demonstrating ratio of negative grip force between them.

Because the use of pulling action is more important when they throwing technique [12),13),18)] muscle training and pulling drill is often practiced [2 7)].

However, this study showed that there was no difference in grip force between hanging action and pulling action as a whole.

Six gripping patterns out of eight gripping patters showed positive correlation between positive grip force and negative grip force. It means that if

positive grip force increases, negative grip force increases accordingly which corresponds with the result of Ono [19] and Furuya. *et al.* [1]

None of the eight gripping patters showed significant correlation between positive grip force and the ratio of negative grip force in positive grip force.

It means that there is no significant between the degree of positive grip force and the degree of performed negative grip force.

The comparison of negative grip force A and B showed that there was significant difference between the ratio of A and B over positive grip force only at shallow grip in all four gripping patterns. In six gripping patterns out of eight gripping patterns, negative grip force B showed significant. It indicated that judoists can perform larger force when they grip with the wrist joint at an inwardly flexed position than with the wrist joint extending forward at an intermediate shoulder level position.

It could be the reason that when he/she performs throwing technique such as Seoinage, Taiotoshi, Uchimata, and Haraigoshi, etc. in both hanging action pulling action, there are many opportunity to perform the movement of wrist joint such as squeezing hanging action in order to protect from throwing technique or inducing imbalance . Further study should be done on non-athletes and other sports athletes to confirm these results.

【Summary】

In order to clarify the characteristics of judoist' s grip, twenty university students who belong to judo club were tested to measure their positive grip force and negative grip force. The results were as follows.

1. Comparison between hanging action and pulling action

When judoists perform throwing techniques, the use of pulling action was especially more important in general, which led negative grip force to be used more often. There is almost no difference in grip force between hanging action and pulling action in this study.

2. Correlation between positive grip force and negative grip force

There was positive correlation, that is, if positive grip force increases, negative grip force increases accordingly. However, there was no significance relationship between positive grip force and the ratio of the performing negative grip force.

3. Comparison between negative grip force A and negative grip force B

Even though non-athletes and other sport athletes were not tested, it was clear that judoists were able to perform larger force when they grip with the wrist joint at an inwardly flexed position than with the wrist joint extending forward at an intermediate shoulder level position.

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# 柔道選手の握力の特性

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キーワード：柔道選手、握力、能動的握力、受動的握力

【要 旨】

柔道選手の握りの特徴を明らかにしようとする目的で20名の被験者を用いて、能動的握力、受動的握力の観点から調べた。

能動的握力の測定にはスメドレー式握力計を使用し、体力テストと同様の方法で測定した。受動的握力の測定方法は「握り」の部分を作成し、これにワイヤーを繋ぎ、組合せプーリーによって牽引した。ワイヤーの途中にはデジタル力量計を用い、力量計に加わった最大筋力をデジタルダイナモメーターで表示した。測定の種類は前腕および手関節を中間位に固定した状態での握る力（以後これを受動的握力 A とする）と前腕を中間位で手関節を出来るだけ屈曲した状態での握る力（以後これを受動的握力 B とする）の２種類の受動的握力を測定し、そのそれぞれの握りにおいて、深く握った場合（手指の第３関節まで屈曲）と浅く握った場合（手指の第２関節まで屈曲）の２種類の握り方を測定する。つまり、片方の手において４種類の受動的握力の測定を行った。

測定の結果、釣手と引手との比較では一般的に投技を施す場合には引手の使用方法が特に重要視され、また、引手の方により多く受動的握力が使用されているが、本研究の結果では、両者の間に握る力の相違はそれ程認められなかった。

次に能動的握力と受動的握力との相関関係では能動的握力が大きくなれば、それに伴って受動的握力も増大するという正の相関関係が、また、能動的握力が大きくなるにつれて、受動的握力を発揮する割合は低下するという、負の傾向が見られたが相関には有意性は認められなかった。

また、受動的握力 A と受動的握力 B との比較では、一般学生や他のスポーツ選手との比較は出来なかったが、少なくとも柔道選手では、手関節を中間位の状態で握る力よりも、手関節を屈曲位の状態での握る力の方がより強い力を発揮することが明らかになった。