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### **Comprehensive Hand Strengthening In Therapy**

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#### **Abstract:**

A dramatic evolvement is currently in process regarding the utilization of comprehensive hand muscle strengthening programs in therapeutic treatment and injury prevention. The effectiveness of traditionally conservative hand health protocols is currently being questioned. Old approaches are in the cross hairs of progressive evaluation efforts. Recent studies regarding disease management have opened the door to follow-up and change in hand strengthening theories and their utilization.

One recent study (in data to follow) concludes that rheumatoid arthritis sufferers receive the most benefit from a full range of motion hand muscle strengthening program, an idea that may modernize arthritis treatment protocols. Health care experts and disease-specific organizations are posting data on their websites and releasing educational material in support of the use of comprehensive strengthening efforts in relation to disease management.

To follow is 1) a collection of recent data pertaining to the use of hand strengthening in therapy and 2) an evaluation of hand muscle strengthening approaches, both traditional and modern. This study reviews hand muscle strengthening in therapy and is intended to stimulate further study and advancement of the subject.

# Part I

## Review of Literature For Hand Strengthening In Therapy

### 1. Hand Strengthening In Arthritis

A study done recently in the UK evaluates the use of hand-strengthening exercises in managing the rheumatoid arthritis hand.

**Conservative hand therapy treatments in rheumatoid arthritis—a randomized controlled trial (A.V. O'Brien, P. Jones, R. Mullis, D. Mulherin, K. Dziedzic)**, published in November of 2005 in *Rheumatology Advanced Access*.

Their objective of the study was to evaluate the effectiveness of three different therapeutic approaches in the management of the rheumatoid hand. All groups received joint protection (JP) advice from a therapist at baseline. Group one performed additional hand-strengthening home exercises, group two performed hand-stretching exercises and group three received no addition to the JP information. The primary outcome was the Arthritis Impact Measurement Scales II (AIMS II) (Upper limb; hand and finger function sub-scales). The differences in AIMS change scores between group 1 and groups 2 and 3 were statistically significant.

Conclusions:

1. Statistically significant improvements in arm function have been demonstrated following a program of hand-strengthening home exercises.
2. A simple home strengthening program can enhance the hand function of the patient with RA.
3. A combination of strengthening and mobilizing exercises with advice on joint protection improves hand function and grip strength in an individual with RA more effectively than advice with simple stretches or advice alone.

### 2. Hand Strengthening In Arthritis

Another study is from South Africa.

**The affect of a long-term exercise program on the rheumatoid hand (S.W. Brighton, J.E. Lubbe, C.A. Van Der Merwe, University of Pretoria, Pretoria, South Africa)**, published in the *British Journal of Rheumatology*, 1993, 32, 392-95.

Their objective was to compare a control group that was given a variety of hand exercises versus a control group given none. Results were determined over a period of 4-year period.

Their conclusions were as follows:

"From this study, it would appear that a regular home exercise program for the rheumatoid hand is beneficial as far as the grip and pincer grip strength are concerned. The range of motion in the MP and PIP joints deteriorated over the 4 year period as could be expected with active RA, but those regularly doing the home exercise program fared better than the controls."

### 3. Arthritis and Vigorous Physical Activity

Dorothy Dunlop and colleagues from Feinberg School of Medicine and the Rehabilitation Institute of Chicago described the findings of their study of over 5,700 women and men aged 65 and older with arthritis in an article published in the April issue of the journal Arthritis & Rheumatism.

The researchers found that lack of regular vigorous physical activity almost doubled an arthritis patient's odds for functional decline and eventual disability in basic daily tasks essential to maintaining independence.

### 4. Strengthening and Osteoporosis

The Osteoporosis Canada website currently posts a "What Exercise Is Best" article in its "About Osteoporosis" section. In the article, Osteoporosis Canada suggests using resistance exercise to build bone mass for the osteoporotic patient.

"Resistance exercise involves moving objects or our own weight to create resistance. This type of exercise works and strengthens a particular muscle group, which in turn strengthens bone in that area. The use of free weights, weight-training machines or exercise bands are examples of resistance exercise."

### 5. Carpal Tunnel Syndrome (CTS) and Hand Strengthening

C. Ted Ostrem specializes in biomechanics and exercise physiology as it pertains to Repetitive Stress Illnesses.

"By strengthening the weaker extensors in the hands and forearms that have been left in a relative state of underdevelopment, the abnormal pressures in the carpal tunnel and on the median nerve are greatly reduced, allowing the body's natural healing processes to function."

"If, as studies have shown, that one can often experience a reduction or even elimination of existing symptoms by balancing the over-and-underdevelopment condition of the muscles and tendons through stretching and strengthening exercises, then it would seem that would be a course of action to seriously investigate.

"Likewise, if methods of prevention were implemented instead of merely shrugged off as non-priorities, then many of today's CTS cases would never have materialized."

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## 6. Hand Strengthening and Grip Strength

Many therapeutic efforts are focused on re-establishing grip and grip-strength as a central part of the rehabilitation process. Some examples of these conditions are trauma (surgery, fracture, etc.), neuropathy (stroke, etc.) and myopathy.

Dr. Janet Travell is a medical doctor and soft tissue expert who has consistently acknowledged the use of a comprehensive strengthening approach to address grip strength training and rehabilitation. For whatever reason, this insight has been largely ignored until recently.

"Strong agonist-antagonist interactions are needed between the flexors and extensors of the hand and fingers to produce forceful hand-grip. Powerful flexion of the distal phalanges requires strong activity also of the finger extensors."  
Janet G. Travell, M.D. and David G. Simons, M.D. Myofascial Pain and Dysfunction -The Trigger Point Manual. Volume1 Upper Extremities, Ch: 35, pg. 501. Copyright 1983.

## Part II

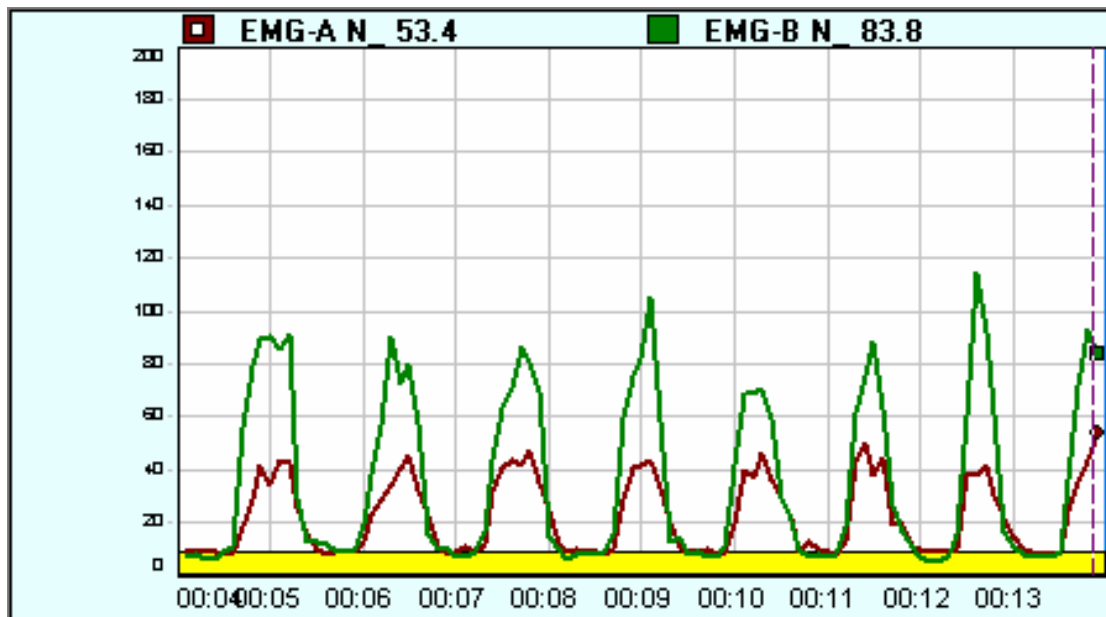
### EMG Evaluation of Hand Strengthening Modalities

The term “hand-strengthening” has taken on a very vague definition throughout the evolution of health and fitness and has traditionally been thought to be synonymous with “grip-strengthening.” Many movements within the therapeutic environment are finding this to be a gross misunderstanding—even to be a dangerous and costly misunderstanding. The idea of “comprehensive hand-strengthening” is beginning to remove itself from the pack as impressive application outcomes and attention to disease management outcomes arise.

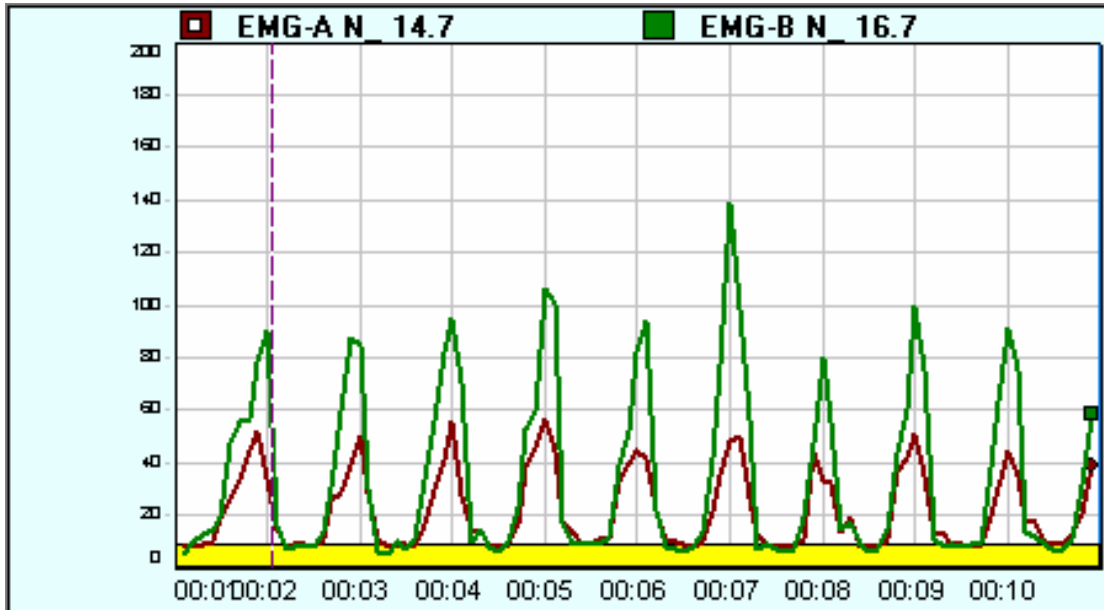
To follow is a presentation of surface electromyography (sEMG) results, which analyze the change in muscle activity (electrical potential) in the finger flexor and finger extensor muscle groups using traditional “grip-strengthening” approaches (spring-loaded using Digiflex and squeeze ball using Theraband and Eggserciser) and modern “comprehensive hand-strengthening” approaches (using Handmaster Plus).

The J&J Engineering I-330 C2 Mini-sEMG was used in various trials with 2 male subjects using each different modality. With each subject, two sEMG leads were established by palpation against isolated finger flexion and finger extension respectively. Red chart lines define the activity of the finger flexor muscle belly; green chart lines define the activity of the finger extensor muscle belly. Discussions of sEMG charts are to follow. Energy output figures and comparisons will also be discussed.

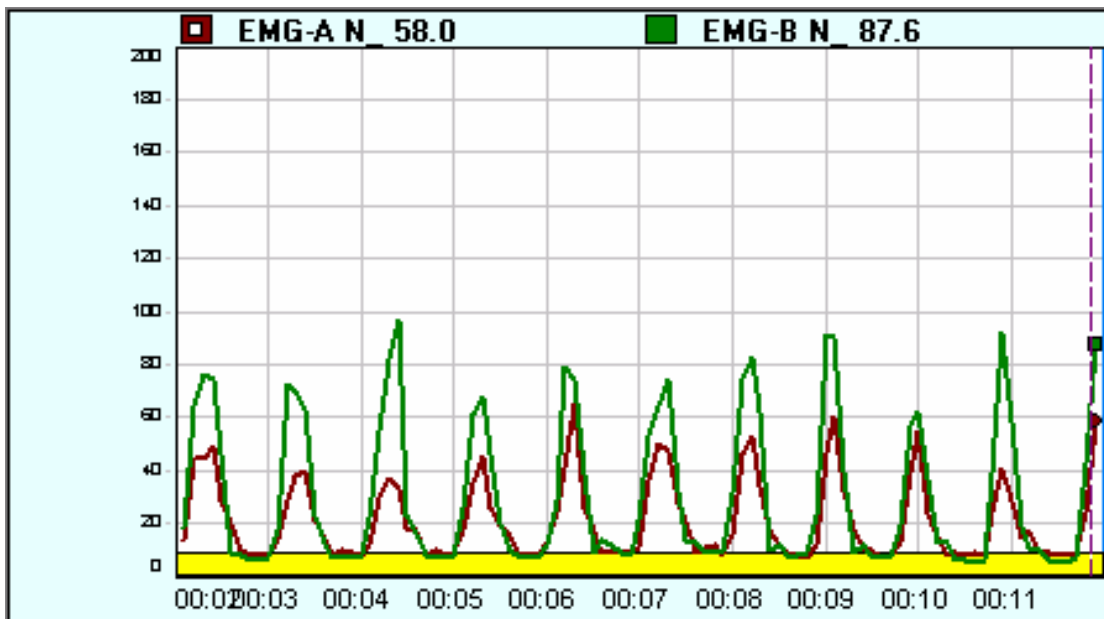
#### SUBJECT A – Spring Loaded Grip (Digiflex)



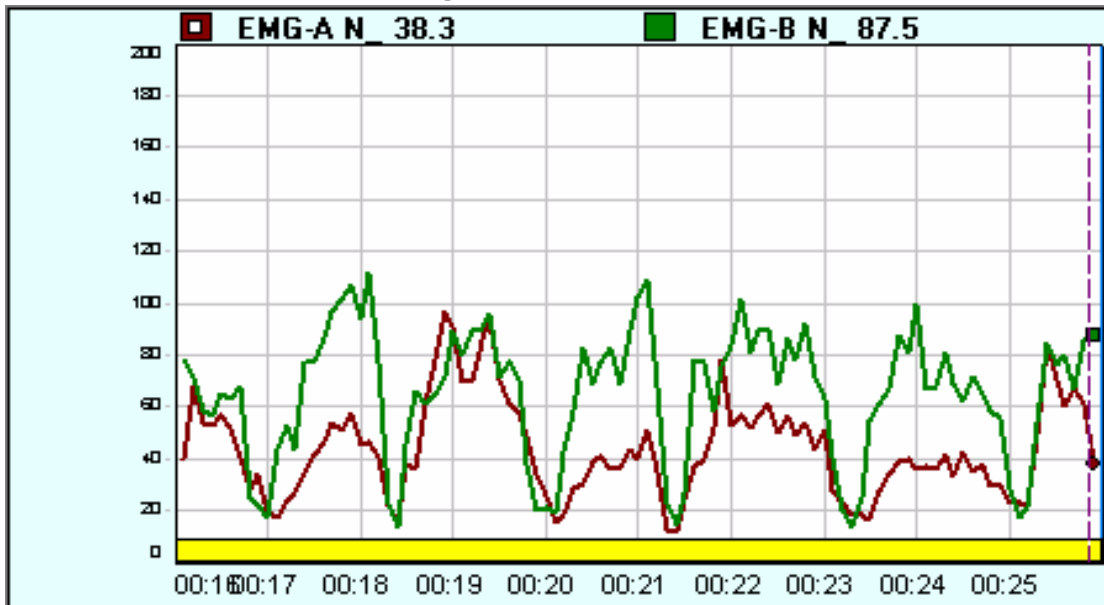
### SUBJECT A – Squeeze Ball (Theraband)



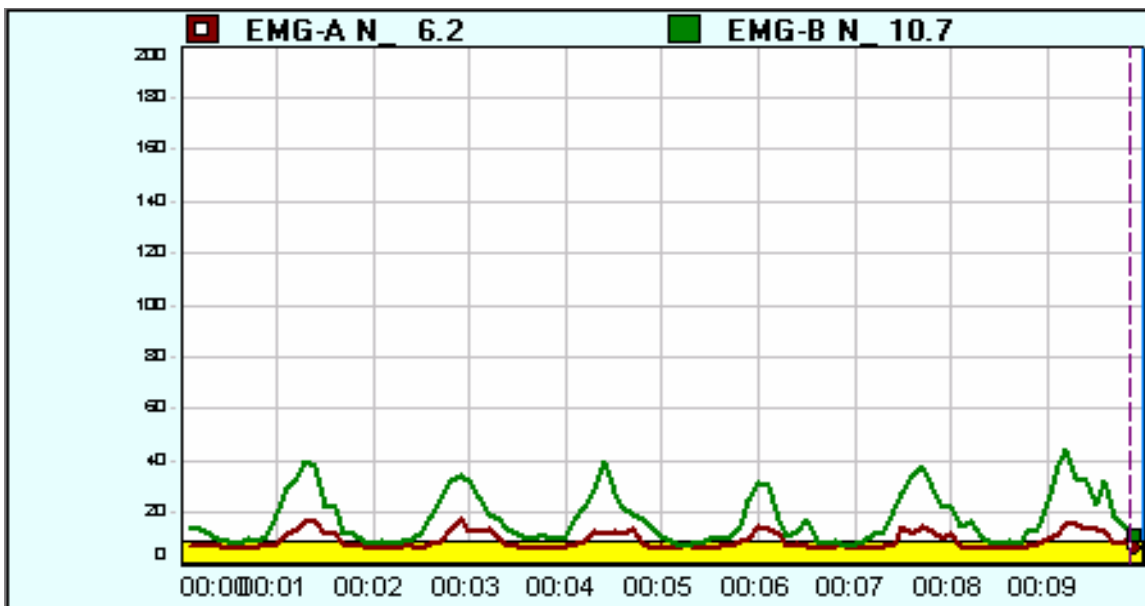
### SUBJECT A – Squeeze Ball (Eggserciser)



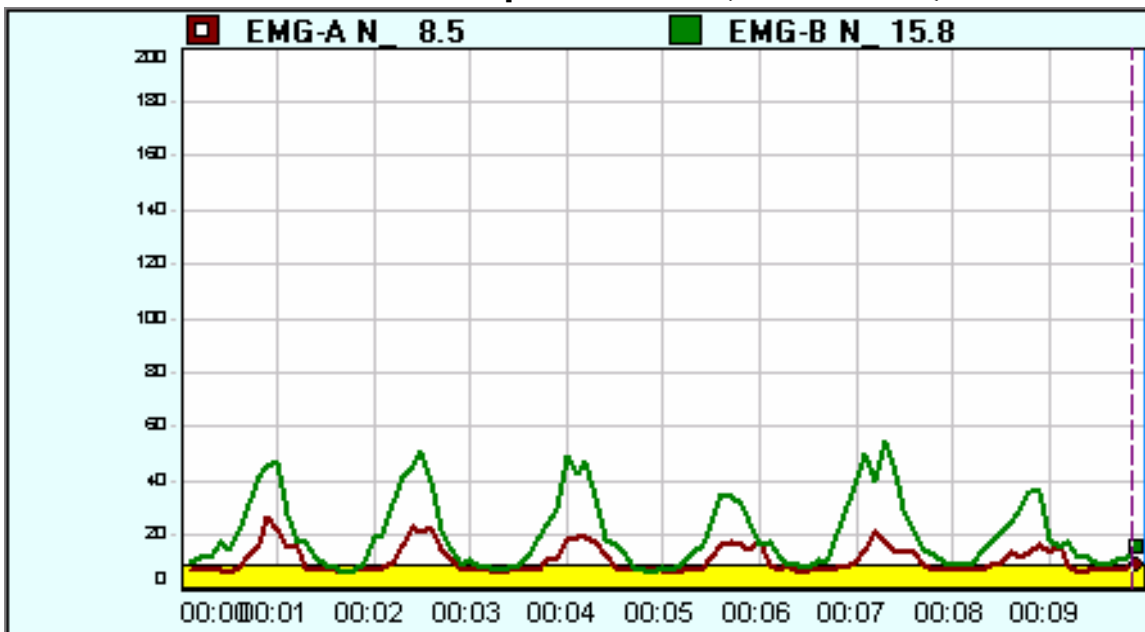
### SUBJECT A – Comprehensive (Handmaster Plus)



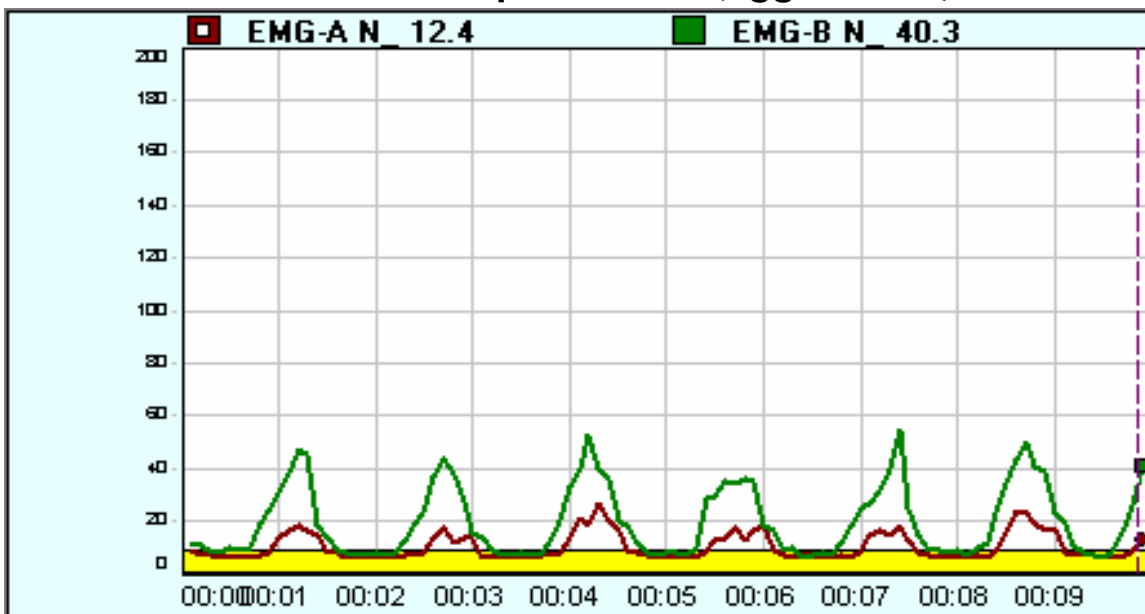
### SUBJECT B – Spring Loaded Grip (Digiflex)



### SUBJECT B – Squeeze Ball (Theraband)

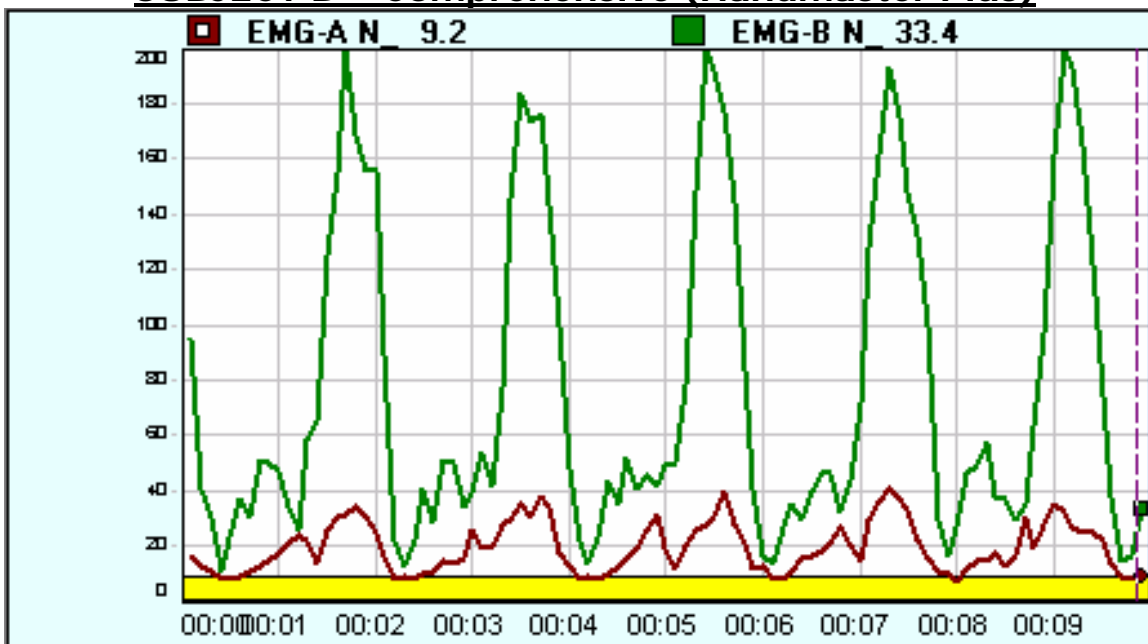


### SUBJECT B – Squeeze Ball (Eggserciser)





## SUBJECT B – Comprehensive (Handmaster Plus)



### Discussion of sEMG Results

Upon observation of sEMG findings, it is clear that a more comprehensive hand-strengthening approach that takes into consideration the participation of all hand muscles as opposed to the favoring the grip or flexion muscles provides a more complete hand-strengthening program. It is important to note that sEMG is used to analyze and compare muscle activity patterns only and is not meant to provide quantification. When a therapist now deliberates the direction to proceed with treatment protocol, these patterns are vital for a number of reasons—all which will require further study.

- 1) Length and tonicity of muscles and tendons
- 2) Mechanical joint balance
- 3) Blood flow to the tissues
- 4) Venous and lymphatic drainage away from the site
- 5) Convenience to the patient (ease of compliance)

Notice the narrow, low spikes from both the finger flexor and extensor muscle signal of the grip-only devices (Digiflex, Theraband and Eggserciser), especially when compared to the comprehensive hand-strengthening device (Handmaster Plus). This pattern illustrates resistance through a very small range of motion as opposed to the wider and somewhat higher spikes (especially in SUBJECT B) resulting from using the comprehensive hand-strengthening approach.

Resistance through as wide of a range of motion as possible is important in all strengthening exercise, not only in regard to equalizing tone of reciprocal muscle group surrounding all joints, but also in stimulating maximum circulation (blood flow, venous flow, lymphatic drainage) to and from all tissues (muscle, tendon, fascia, cartilage, bone, etc.) involved. Additional study is required to further explore the benefits of balanced hand strengthening exercise through full ranges of motion.

### Comparative Output (Effort) Required By Modality

#### SUBJECT A

Task	Time	EMG-A N_	EMG-B N_
1	0:00:05	13.1	21.28
Digiflex	0:00:10	20.92	32.9
	0:00:15	22.11	34.03
	0:00:20	19.64	28.14
	0:00:25	21.46	32.72
<b>AVG.</b>		<b>19.45</b>	<b>29.81</b>

Task	Time	EMG-A N_	EMG-B N_
2	0:00:05	21.59	35.92
Theraband	0:00:10	20.63	31.56
	0:00:15	23.32	30.57
	0:00:20	24.47	37.23
	0:00:25	20.78	28.13
<b>AVG.</b>		<b>22.16</b>	<b>32.68</b>

Task	Time	EMG-A N_	EMG-B N_
3	0:00:05	19.34	28.08
Eggsercis	0:00:10	22.52	30.4
	0:00:15	18.8	25.07
	0:00:20	21.88	28.13
	0:00:25	21.4	29.68
<b>AVG.</b>		<b>20.79</b>	<b>28.27</b>

Task	Time	EMG-A N_	EMG-B N_
4	0:00:05	31.38	43.46
HM+	0:00:10	44.18	58.53
	0:00:15	54.45	78.48
	0:00:20	48.75	63.28
	0:00:25	37.18	66.21
<b>AVG.</b>		<b>43.19</b>	<b>61.99</b>

#### SUBJECT B

Task	Time	EMG-A N_	EMG-B N_
1	0:00:05	8.9	17.27
Digiflex	0:00:10	8.83	17.19
	0:00:15	9.93	19.26
	0:00:20	10.08	18.93
	0:00:25	10.62	20.99
<b>AVG.</b>		<b>9.67</b>	<b>18.73</b>

Task	Time	EMG-A N_	EMG-B N_
2	0:00:05	10.56	20.34
Theraband	0:00:10	10.33	20.2
	0:00:15	11.39	20.03
	0:00:20	11.8	21.05
	0:00:25	11.13	19.27
<b>AVG.</b>		<b>11.04</b>	<b>20.18</b>

Task	Time	EMG-A N_	EMG-B N_
3	0:00:05	9.63	18.13
Eggsercis	0:00:10	10.47	20.78
	0:00:15	11.34	24.03
	0:00:20	10.98	20.51
	0:00:25	11.05	20.07
<b>AVG.</b>		<b>10.69</b>	<b>20.70</b>

Task	Time	EMG-A N_	EMG-B N_
4	0:00:05	18.25	67.16
HM+	0:00:10	20.18	82.46
	0:00:15	25.03	88.63
	0:00:20	22.74	75.12
	0:00:25	25.52	80.14
<b>AVG.</b>		<b>22.34</b>	<b>78.70</b>

## Discussion Of Output Required By Modality:

Notice that the grip-only modalities deliver a much less complete and effective workout (52% less in flexion and 51-75% less in extension) when compared to the comprehensive hand-strengthening device (2x as effective in flexion and 2-4x as effective in extension). Grip-only devices resist through a small range of motion and involve fewer muscle groups. Grip-only hand strengtheners will be replaced by comprehensive hand strengthening approaches (i.e. Handmaster Plus) in response to modern society's attention to hand muscle weakness and imbalance and the growing cost of arthritis, osteoporosis, an array of repetitive stress injuries (RSI's) such as carpal tunnel syndrome and tennis elbow and rehabilitation in general.

## Summary:

1. Modern researchers, therapists and disease specific organizations recognize the value of comprehensive hand strengthening in therapy.
2. Further research is required to explore the potential uses of comprehensive hand strengthening within the treatment protocols of an array of disease management, injury prevention and injury rehabilitation applications.
3. Researchers and leaders in human biomechanics and exercise physiology are placing more emphasis on balanced strengthening approaches in relations to prevention, rehabilitation and disease management.
4. Comprehensive hand strengthening, such as that provided by the Handmaster Plus device, is a more effective and complete hand strengthening approach (2x as effective in flexion and 2-4x as effective in extension) when compared to the traditional grip-only approach to hand strengthening.
5. Grip-only hand strengthening is archaic in regards to effectiveness and completeness especially when compared to a comprehensive hand strengthening approach (52% less in flexion and 51-75% less in extension).
6. Additional studies using larger, more varied sample sizes are encouraged.