The Effects of the ARMAID™ on Severity of Symptoms (Including Pain, Tingling, Weakness, and/or Stiffness), Grip Strength, and Level of Function in Subjects with Symptoms Associated with Upper Extremity Repetitive Strain Injury

Michael Greiner, MOT, OTR and Daniel Cicchelli, RPT

ABSTRACT Greiner MT, Cicchelli, DC. The Effects of the ARMAID™ on Perceived Severity of Symptoms (Including Pain, Tingling, Weakness, and/or Stiffness), Grip Strength, and Perceived Level of Function in Subjects with Symptoms Associated with Upper Extremity Repetitive Strain Injury. *Useful Products Inc. 1999*

Objective. The purpose of this study was to investigate the efficacy of the ARMAID™ in treating symptoms associated with repetitive strain injuries (RSI). The ARMAID provides self-administered treatment through the basic principles of massage. The study examined three (3) variables: 1) perceived severity of symptoms, 2) grip strength, and 3) perceived level of function. ***Methods.*** A pre-test, post-test design consisting of forty (40) pre-screened subjects who were randomly categorized into two sub-groups: subjects utilizing a three (3) week ARMAID protocol, and a control group (n = 40). The DASH (Disabilities of the Arm, Shoulder, and Hand) Outcome Measure, and the Jamar dynamometer were administered as pre-test and post-test tools for evaluation of the three dependent variables. All subjects reflected on their experiences weekly by filling out the DASH Outcome Measure. ***Results.*** Results indicated a significant improvement in level of function and a decrease in severity of symptoms after the three-week ARMAID protocol. Use of the ARMAID also had a positive effect on grip strength in people with symptoms associated with repetitive injury.

KEY WORDS: Repetitive Strain Injury, Massage, Self-Administration

Repetitive Strain Injury (RSI), otherwise known as cumulative trauma disorder, is not a diagnosis, but an umbrella term used to describe work related disorders of tendons, muscles, joints, nerves, blood vessels and other tissues of the body. RSI develops as a result of repetitive and forceful movements, awkward postures, inadequate rest time, and other ergonomic hazards (Lucas & Cushall, 1992). The ergonomic hazards that generally pose a risk to a person are: mechanical stress that requires static muscle loading, such as typing on a keyboard; vibration or temperature extremes, from the use of some tools; and poor postures that result from improperly designed workstations or equipment. Although RSI may occur as a result of sport or recreational activities, occupational RSI is the overwhelming majority, and can be more easily diagnosed

and managed. RSI can transpire anywhere in the body, but most commonly occur in the arms, neck and back. Common symptoms of RSI include pain, swelling, numbness, tingling, sleep disturbances, early fatigue, and the inability to perform normal activities. The effects of RSI can seriously compromise a person's ability to work or accomplish regular daily activities such as driving, brushing his/her teeth, or folding laundry. With a growing number of RSI cases, remedial and/or preventative measures must be taken to address this problem.

The ARMAID is a self-administered massage therapy device designed to provide deep tissue massage to the muscles and other soft tissues of the forearm, wrist, and hand. A lever arm system equipped with handles, rolling balls, and supportive padding allows the operator the ability to control the amount of pressure applied and location of the massage. The ARMAID uses the principles of therapeutic massage to attain desired goals.

LITERATURE REVIEW

Literature regarding RSI as an occupational hazard dates as far back as 1713. An Italian text entitled *Disease of Workers*, written by Italian physician Bernardino Ramazzini, states that a person in the workplace can experience "certain violent and irregular motions and postures of the body, by reason of which the natural structure of the vital machine is so impaired that serious diseases gradually develop therefrom" (Lucas & Cushall, 1992). More recently, RSI has been divided into specific syndromes depending on their relative symptoms and areas of presentation. Examples include Carpal Tunnel Syndrome, Tendinitis, Tenosynovitis, and Thoracic Outlet Syndrome. RSI can affect any part of the body, and is caused by injury to nerves, tendons, tendon shealths, or muscles. Moreover, RSI can result in the inability to continue working, lost wages, and psychological trauma (Lucas & Cushall, 1992). Statistics show that in 1982, some eight percent (8%) of work-related injuries were caused by RSI. Only five years later, RSI accounted for thirty-eight (38%) of injury in the workplace. Statistics now show that greater than sixty percent (60%) of work-related injuries are attributed to RSI (Lucas & Cushall, 1992). Today, RSI is collectively considered the most common work-related injury, costing employers over $100 billion annually (Meyer, 1995). Stress and increased mechanisation in the workplace are two primary contributors to the rising number of RSI cases. The occupational sectors most commonly associated with these risk factors are operators of machinery and users of computers (Yassi, 1997). Although typing at a computer is most commonly known as the activity that may cause the disorder, heavy lifting, working in cramped spaces, and the use of vibrating tools are a few activities that may also attribute to RSI (Meyer, 1995).

Therapeutic remedies for RSI include rest, heat, cold and massage as conservative measures. If these options do not relieve symptoms, the affected body part can be immobilized with a splint. As a last resort, a physician may opt for steriodal injection(s) or surgical intervention as indicated (Boston Women's Health Book Collective, 1991). Although there is a need for more cost-effective treatment approaches and preventative measures, ergonomic training in the workplace and conservative remedies have been effective in decreasing the injury rate (Yassi, 1997). In the past, massage has been used to address the symptoms of RSI. Massage increases blood circulation in the affected area, allowing for the body's

tissues to heal more quickly (Lucas & Cushall, 1992). It is also documented that massage, particularly deep massage, can be used to decrease muscle spasm and stiffness (Kisner & Colby, 1996). Dr. Emil Pascarelli, author of the book *Repetitive Strain Injury: A Computer User's Guide* (1994), states that deep tissue massage, performed one to three times a week for several weeks will help to reshape scar tissue, allowing the muscle(s) to heal. The author also states that "muscles and other soft tissues need to move to remain healthy" (Pascarelli & Quilter, 1994). Massage manifests this effect by stretching muscle, breaking adhesions in connective tissue structures, and remodeling scar tissue. This type of stretching and tissue manipulation keeps muscles "supple, toned, and pain free" (Pascarelli & Quilter, 1994). Other effects of massage include mechanical mobilization of skin, tendons, and subcutaneous tissue, increased flow of nutrients which aid in healing, and physical and psychological relaxation and relief of tension (De Domenico & Wood, 1997). It is clear that decreased functional ability is a major concern facing persons with RSI. Previous studies have pointed out the need for further research concerning conservative methods of treatment and preventative approaches to this disorder. Although literature has supported the efficacy of massage in treating the symptoms associated with RSI, this investigation is the first controlled study regarding the use of the ARMAID in subjects with symptoms associated with upper extremity RSI.

PURPOSE

The purpose of the study is to determine the efficacy of the ARMAID on subjects with RSI of the forearm, wrist, and/or hand. If use of the ARMAID results in increased grip strength, decreased severity of symptoms, and/or improved upper extremity function, this may facilitate overall improved functional ability and quality of life.

HYPOTHESIS

A hypothesis was established for each dependent variable.

- In subjects with symptoms associated with upper extremity RSI, the ARMAID has no significant effect on grip strength.
- In subjects with symptoms associated with upper extremity RSI, the ARMAID significantly improves perceived severity of symptoms (including pain, tingling, weakness and/or stiffness).
- In subjects with symptoms associated with upper extremity RSI, the ARMAID significantly improves perceived level of upper extremity function.

ASSUMPTIONS

It is assumed that the parameters as defined by the literature regarding therapeutic massage are adequate parameters for the ARMAID study protocol.

DEFINITION OF TERMS

Repetitive strain injury (RSI): A variety of musculoskeletal disorders generally affecting muscles, tendons, joints, peripheral nerves, and vascular structures. Most commonly affected areas include the upper extremities, neck, and back, although RSI can occur anywhere in the body. These injuries result from considerable repetitive and forceful motions, poor postures, and other ergonomic and sports, or work-related hazards. For the purposes of this study,

RSI of the forearm, wrist, and/or hand will be addressed.

Massage therapy: Manipulation of soft tissue by human hands, or by electrical, mechanical or hydraulic forces, with the goals of attaining increased circulation of blood and lymphatic fluid, decreasing muscle spasm and stiffness, reducing edema, reducing pain, and re-aligning connective tissue structures. Methods of application of massage include stroking, kneading, friction, tapping, and vibration.

ARMAID: The ARMAID is a self-administered massage therapy device designed to provide deep tissue massage to the muscles and other soft tissues of the forearm, wrist, and hand. A lever arm system equipped with handles, rolling balls, and supportive padding allows the operator the ability to control the amount of pressure applied and location of the massage. The ARMAID uses the principles of therapeutic massage to attain desired goals. As the user places increased pressure on the device with his or her hand, the pressure exerted on the soft tissues of the treatment area also increase.

RESEARCH DESIGN

A pre-test, post-test experimental design was used. In this study, the independent variable was the ARMAID. The dependent variables were grip strength, level of severity of symptoms (including pain, tingling, weakness, and/or stiffness), and level of upper extremity function.

SUBJECTS

Subject recruitment was initiated through public advertisements in two (2) newspapers that were distributed throughout San Diego County. Because the study was interested in collecting individuals who suffer from symptoms associated with RSI, it was necessary to establish subject criteria. Subject selection criteria was adapted from a previous study that developed an assessment tool for thirty-eight (38) carpal tunnel patients as a method of self-evaluation (Levine, D., Simmons, B., & Koris, M., 1993). Subject criteria was as follows:

- Complaints of pain, tingling, weakness, and/or lack of mobility in the forearm(s), wrist(s), and/or hand(s).
- History of symptoms with a minimum duration of two (2) weeks.
- Presently unable to attain desired function in completing work or personal projects.
- No diagnoses or past history of any major systemic diseases.
- Not currently undergoing any skilled rehabilitation or medicinal intervention for painful forearm, wrist, and/or hand condition(s).
- Not currently taking prescription pain medication(s).
- No compromise to skin integrity of the involved upper extremity.
- 18-65 years of age.

The study utilized convenience sampling with randomization for assignment in both an experimental and a control group. A sample of forty (40) subjects was randomly categorized in the two study groups. The ages of the subjects ranged from 26-65 ($M = 38.89$, $SD = 8.23$). Sixty percent (60%) of the subjects were female. Forty percent (40%) of the subjects were male. Fifty percent (50%) of the subjects had previously sought medical attention for their symptoms. Thirty percent (30%) of the subjects were diagnosed with RSI.

INSTRUMENTATION

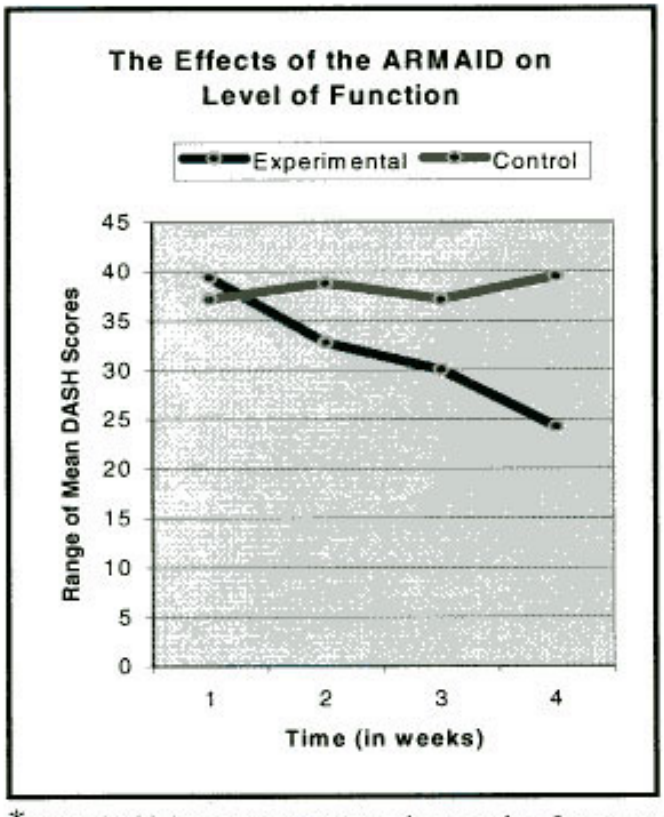
The instrumentation included the DASH (Disability of the Arm, Shoulder, and Hand) Outcome Measures and the Jamar dynamometer. The DASH was used to measure the following two dependent variables: perceived severity of symptoms (including pain, tingling, weakness, and/or stiffness), and perceived level of upper extremity function. The DASH consisted of three (3) modules. Module one (1) was thirty questions asking the subject to rate their ability to accomplish various activities within the last week. The rating system was comprised of a one to five (1-5) scale (ie. 1 = No Difficulty, 5 = Unable). Five questions within module one (1) asked the subject to rate their severity of symptoms on a one to five (1-5) scale (1 = None, 5 = Extreme). Module two (2) was four questions asking the subject to rate their ability to perform sports/performing arts within the last week. Module three (3) was four questions asking the subject to rate their ability to perform work activities within the last week. Module two and module three were both optional, and were comprised of a one to five (1-5) scale (1 = No Difficulty, 5 = Unable). Raw DASH scores ranged from thirty to one-hundred fifty (30-150) and then were converted to a zero to one-hundred (0-100) scale. A score of zero (0) indicated "no disability," and a score of one-hundred (100) indicated "a lot of disability" (Upper Extremity Collaborative Group, 1996). In a recent study, Measure of Disability and Symptoms of the Upper Limb: A Validation Study of the DASH Questionnaire (Amadio, P., Beaton, D., & Bombardier, C., 1993), the DASH was able to discriminate across levels of both overall health and severity of condition ($p<0.001$), and was sensitive to upper limb disability. There was no apparent data supporting the reliability of the DASH. Therefore, coefficient alpha was computed to determine the scale's reliability with the current study's sample. Test results revealed reliability scores for the scale as a whole (.823) and for each of the three parts therein (Module one = .556, Module two = .860, Module three = .858).

The Jamar dynamometer was used to measure grip strength. The evaluation of hand function has been determined by the Jamar dynamometer. The Jamar dynamometer has been an accepted test of grip strength, and is regularly part of physical examination (Ashford, R., Nagelburg, S., & Adkins, R., 1996). "The reliability and validity of the Jamar dynamometer has been stressed and has been found to be the standard of objective grip strength measurements" (Harkonen, R., Harju, R., & Alarante, H., 1993).

PROCEDURE

The forty subjects were randomly categorized into two sub-groups: 1) twenty subjects in an experimental group and 2) twenty in a control group. As part of the pre-test, post-test design, subjects of both groups were asked to complete the DASH Outcome Measure. Relevant data including hand dominance and symptom affected limb(s) was recorded. Dynamometer readings were taken in pounds according to the Jamar's established standards, and an average of three (3) trials was recorded for each subject. Grip strength measurements were taken from the involved extremity. In the event that the subject had bilateral involvement of the upper extremities, readings were taken from the extremity with greater involvement. The experimental group was then instructed in the ARMAID protocol (See Appendix A). As a means to obtain data on immediate

effects of the ARMAID, the experimental group was asked to carry out the protocol on the involved extremity (or more involved). Then a second average of dynamometer readings was recorded. Interval recordings of weekly progress were measured with the DASH in both experimental and control groups. All subjects were given self-addressed stamped envelopes containing interval DASH questionnaires to be completed and returned on a weekly basis. Appointments were scheduled for all subjects to return for post-test measurements exactly three (3) weeks after pre-test measurements were recorded.



*Range 0-100, lower score represents less severity of symptoms

DATA ANALYSIS

A) Perceived Level of Function

Experimental Group

Pre-test DASH scores ranged from 14.17 to 72.50 (M = 39.38, SD = 11.04). Post-test DASH scores ranged from 1.67 to 68.33 (M = 24.21, SD = 14.54). Recall that a low score is indicative of less disability than a higher score (0 = no disability, 100 = a lot of disability). The pre-test and post-test mean scores show an overall experimental group change of 15.17 points on the DASH. This is indicative of an improvement in the perceived level of upper extremity function in the group as a whole. Within the experimental group, pre-test and post-test scores indicated that eighty percent (80%) of the subjects showed some level of improvement in upper extremity function. Ten percent (10%) showed no change in perceived levels of function, and ten percent (10%) showed a decrease in perceived level of function.

Control Group

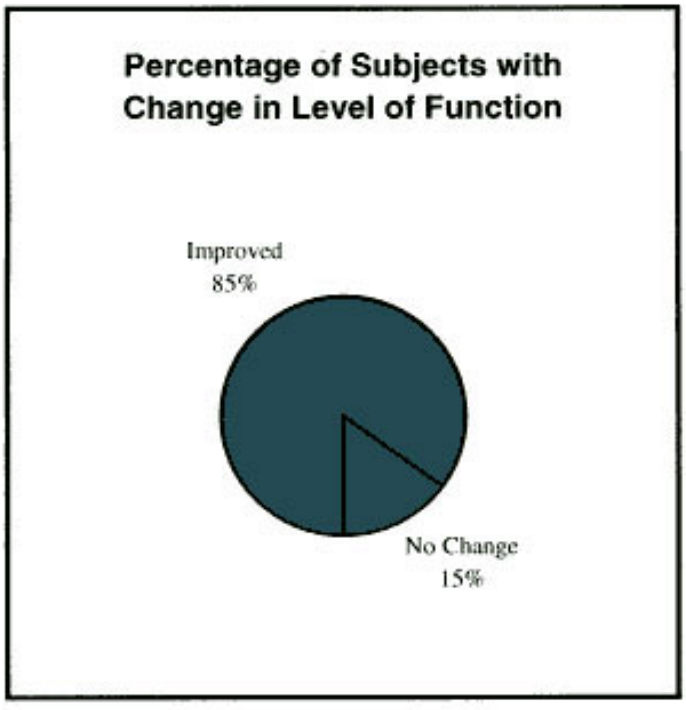
Pre-test DASH scores ranged from 10.14 to 71.33 (M = 37.15, SD = 14.60). Post-test DASH scores ranged from 7.89 to 73.76 (M = 39.45, SD = 13.29). The pre-test and post-test mean scores show an overall group change of 2.30 points on the DASH.

B) Perceived Severity of Symptoms (including pain, tingling, weakness, and/or stiffness)

Experimental Group

Pre-test DASH scores ranged from 25 to 80 (M = 56.75, SD = 25.50). Post-test DASH scores ranged from 5 to 55 (M = 29.75, SD = 17.25). Recall that a low score is indicative of no symptoms, and a high score is indicative of extreme symptoms. The pre-test and post-test mean scores show an overall change of 27.00 points on the DASH. The overall change in mean scores indicated that the severity of upper extremity symptoms diminished in the experimental group. Eighty-five percent (85%) of the subjects showed some level of improvement in perceived severity of upper extremity symptoms, and the remaining fifteen percent (15%) showed no change.

Interestingly, none of the subjects showed an increase in severity of symptoms.



Control Group

Pre-test DASH scores ranged from 25 to 80 (M = 57.25, SD = 26.75). Post-test DASH scores ranged from 20 to 80 (M = 56.50, SD = 22.00). The pre-test and post-test mean scores show an overall group change of 0.75 points on the DASH.

C) Grip Strength

Experimental Group

While interpreting the following data, it may be helpful to reference Jamar dynamometer norms (See Table 1). Pre-test dynamometer readings taken from the involved upper extremity ranged from 1.33 to 113.33 (M = 55.98, SD = 8.40). Post-test readings taken from the involved upper extremity ranged from 2.33 to 150.00 (M = 69.20, SD = 7.14). The pre-test and post-test mean scores show an overall increase of 11.22 pounds. Pre-test dynamometer readings from the less involved (or uninvolved) extremity ranged from 8.33 to 139.33 (M = 64.75, SD = 9.15). Post-test reading taken from the less involved (or uninvolved) extremity ranged from 1.66 to 161.33 (M = 70.28, SD = 9.65). The pre-test and post-test mean scores show an overall increase of 5.53 pounds. A second average of scores was taken to obtain data on immediate effects of the ARMAID on grip strength. These scores ranged from 2.66 to 113.66 (M = 62.30, SD = 5.87). The difference between the mean of the second average readings and the mean of the pre-test dynamometer readings of the involved extremity was 6.32 pounds. This indicates that immediately after use of the ARMAID, grip strength recordings increased (See Appendix B). Eighty-five percent (85%) of the subjects showed some level of improvement in grip strength in the involved extremity pre-test to post-test, while the data for only three (3) subjects or 15% indicated a decrease. Ninety percent (90%) of the subjects in this group showed some level of improvement in grip strength in the less involved (or uninvolved) extremity pre-test to post-test, while only two (2) subjects or 10% showed a decrease. By looking at the second average scores, the data shows that fifteen (15) of the twenty (20) subjects or 75% showed some level of improvement in grip strength immediately after using the ARMAID for the first time.

Control Group

Pre-test dynamometer readings taken from the involved upper extremity ranged from 2.66 to 109.33 (M = 58.20, SD = 6.27). Post-test readings from the involved upper extremity ranged from 29.66 to 119.00 (M = 54.75, SD = 12.00). The pre-test and post-test mean scores show an overall increase of 1.55 pounds. Pre-test dynamometer readings from the less involved (or uninvolved) extremity ranged from 31.33 to 126.66 (M = 54.83, SD = 10.38). Post-test readings taken from the less involved (or uninvolved) extremity ranged from 37.33 to 140 (M = 57.79, SD = 11.11). The pre-test and post-test mean

scores show an overall increase of 2.96 pounds.

Table 1

Grasp Dynamometer Norms in Pounds (Mean of Three Trials)

Norms at Age (yr):	20	30	40	50	60	70
Male						
R	121	122	117	113	90	75
L	104	110	113	102	77	65
Female						
R	70	79	70	66	55	49
L	61	68	62	57	46	41

Adapted from Mathiowetz, V., et al. Grip and pinch strength: normative data for adults. Arch. Phys. Med. Rehabil. 66(2):69-74, 1985. Based on a sample size of n = 628, aged 20-94 years. Average standard deviation: males, 28 R and 27 L; females, 17 R and 15 L.

ADDITIONAL ANALYSES

Results of an independent t-test in comparing pre-test and post-test mean scores for grip strength of the involved arm in the experimental group showed a statistically significant change in scores ($t = 12.71$; $p = 0.003$). The same test was performed for the control group and showed no statistically significant change pre-test to post-test ($t = -2.53$; $p = 0.008$). In comparing experimental and control group post-test scores ($t = 8.39$; $p = 0.012$), results indicated a statistically significant change. These statistics suggest that use of the ARMAID resulted in an increase in grip strength over the three-week protocol.

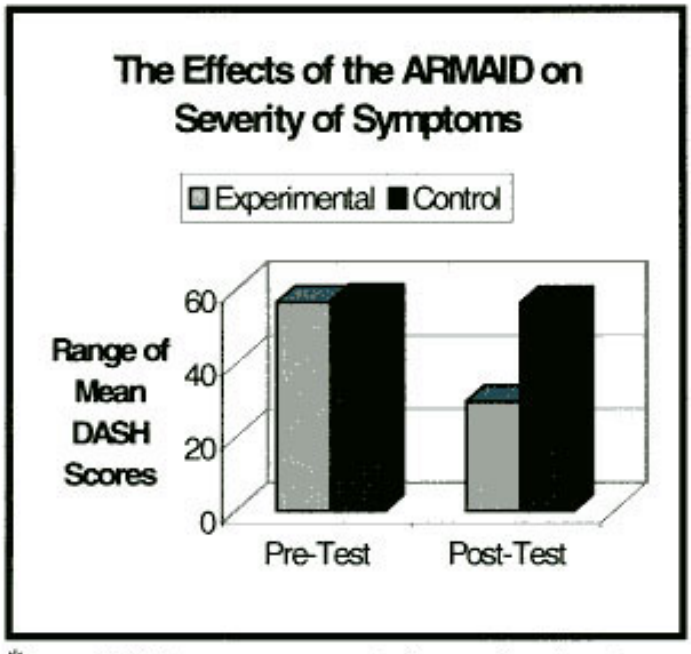
An attempt was made to determine if any correlation existed between severity of symptom scores and level of function scores from the DASH Outcome Measure. A Spearman Rho test indicated a significant correlation existed between the two variables ($r = 0.89$). Therefore, the significant correlation being; as severity of symptoms diminish, the ability to perform functional activities improves.

DISCUSSION

Results of the study indicated a significant increase in grip strength after use of the ARMAID for three weeks. This strengthening is not likely attributed to actual myofibril hypertrophy, but rather due to diminished symptoms, specifically complaints of pain. One may speculate that the decrease in pain is due to the therapeutic effects of massage. In any regard, use of the ARMAID has a positive effect on grip strength in people with symptoms associated with repetitive strain injury. Therefore, our hypothesis regarding grip strength must be rejected because the ARMAID does facilitate improvement in grip strength.

Eighty-five percent (85%) of the subjects had an overall decrease in symptoms associated with repetitive strain injury. Eighty percent (80%) of subjects had a general improvement in level of function. Users of the ARMAID experienced a decrease in symptoms, which may have facilitated them in performing activities more regularly, and with fewer complaints. The authors speculate on several reasons for this phenomenon. Although, no inferential statistics were determined, percentages of improvement in both involved and uninvolved upper extremities cannot be denied. Therefore, these improvements may be attributed to an increased level of confidence during activities requiring bilateral upper extremity use. There is the possibility that neurological overflow could have contributed to this improvement. Otherwise, reasons that have already been speculated upon,

including increased grip strength or a decrease in complaints of symptoms, may have individually or collectively attributed



*Range 0-100, lower score represents less severity of symptoms

to improvements in level of function. A combination of these factors may have lead users to participate in activities with more rigor and regularity, and without regard to activities that may have been precipitating risks in the development of their debilitating symptoms.

Of the questions on the DASH that address severity of symptoms, one specifically refers to the subjects perceived level of stiffness. Although no objective measures were taken for range of motion, the authors speculate that diminished complaints of stiffness may be associated with improved range of motion.

In subjects with symptoms associated with upper extremity RSI, the ARMAID significantly improved perceived severity of symptoms (including pain, tingling, weakness, and/or stiffness). Additionally, the ARMAID significantly improved perceived level of upper extremity function. These finding support their respective hypotheses.

In summary, the ARMAID is efficacious in treating symptoms associated with RSI. This self-administered therapeutic device is an effective conservative modality, which should be implemented in the treatment of workforce injuries to improve overall function and quality of life.

LIMITATIONS

Some limitations remained inherent to this study. First, the generalizability of the results was limited because the sample was chosen from one specific urban area. Secondly, subject criteria could not be verified. Though subjects did have varying levels in severity of symptoms associated with RSI, this does not confirm a diagnosis. Third, although the Jamar dynamometer is an accepted method of measuring grip strength, there is controversy regarding its objectivity of strength measurements based on a learning curve. Finally, the DASH Outcome Questionnaire appeared sensitive to varying levels of ability, however, questions are asked with or without attribution to the affected limb.

Appendix A

The ARMAID™ Treatment Guide

- The ARMAID™ is designed for self-maintenance and temporary relief of symptoms associated with repetitive strain injuries (RSI). Symptoms closely related to RSI include generalized pain in the forearm(s), wrist(s), and/or hand(s). Sometimes painful muscular symptoms may be more localized or specific to certain spots within these muscles. These sensitive pin-pointed spots in the muscle are often referred to as trigger-points. The ARMAID™ has a few specific massage protocols to address these two types of symptoms.

How to use your ARMAID™

- Strap the ARMAID™ around the leg on the same side as the arm you want to massage (e.g. right leg to massage right arm).
- Turn the therapy balls toward the side of the arm you wish to start on and place your free hand on the handles.
- Place your forearm inside the ARMAID™ and adjust the angle of the ARMAID™ to a position approximately 45 degrees from the thigh.

Massage Technique for General Forearm Pain

- With your forearm now in place, paying attention to the center therapy ball, you are able to control the amount of pressure applied to the forearm you are massaging (e.g. a lighter grip on the handles will produce less pressure on the forearm through the center therapy ball).
- Slowly begin to move your arm in specific strokes across the length of the muscle(s) from the wrist towards the upper forearm applying pressure with each stroke then releasing pressure as you return the arm to the starting position.
- Continue this process for **1-3 minutes per session** until symptoms subside or a sense of relief has been achieved. This massage should be performed **2-3 times a day**. It is recommended that you begin with less time, and work your way up to the maximum recommended usage.

Deep Tissue Trigger-point Massage

- You may have found some specific spots within the muscle(s) that were more tender than other areas. Find one of these spots and place the center therapy ball on top of this area.
- Carefully apply the center therapy ball to this spot and create the greatest amount of pressure possible without creating pain. (If you're unable to accomplish this step, do not perform deep tissue massage at this time.)
- Next, make a fist around your thumb and slowly rotate your fist in a large circular motion. First, rotate the fist in a clockwise motion for five repetitions, then in a counter-clockwise motion for an additional five repetitions.

Changing Positions of the ARMAID™

- You may want to massage one or both sides of the forearm of one or both arms. In either case, it will be necessary to rotate the ARMAID™. To reverse the position of the ARMAID™, remove your forearm, and rotate the ARMAID™ so that the therapy balls are facing the opposite side of the forearm from which you just massaged. Follow the procedure as before until completed. When both sides of one arm are done, remove the ARMAID™, switch legs, then follow the same steps to massage the opposite arm.

Tips for Getting the Most Out of Your ARMAID™

- Go slow--there is no substitute for taking the time to learn which type of massage works best for you. Be aware of your response to the different movements and varying degrees of pressure in both types of massage. Only choose massage that feels good and does not increase your pain.
- Be gentle.
- Use massage in moderation. (Remember that the guide recommends working your way up to **1-3 minute sessions, 2-3 times a day** for each forearm position.)
- **Note: When utilizing the ARMAID™ it's easy to overdo it at first. Moderation is the key to getting the best results.**
- If after 2 weeks of use, and the symptoms persist, you may need to consider options beyond the scope of the ARMAID™.
- Be sure to consult your physician and ask him/her as to how self-massage may help meet your specific needs

Appendix B

Pre-test and Post-test Jamar Dynamometer Readings

Pain	Dominant Pre-test	Dominant Post-test	Change Dominant	Non-Dominant Pretest	Non-Dominant Post-test	Change Non-Dominant	Initial Post-Use
R>L	52	60	8	49	59	10	59
R	37.33	46	8.67	37	40.66	3.66	38
R	30	38.66	8.66	31	42.33	11.33	36
R>L	65.33	62	-3.33	48.66	52	3.34	71
R>L	47.33	61.33	14	42.33	40.33	-2	45.66
R	1.33	2.33	1	8.33	1.66	-6.67	2.66
R	66	45.33	-20.67	56	46.33	-9.67	68
R>L	60	62.33	2.33	53.33	56.33	3	53.66
R	112.66	115.33	2.67	97	109.33	12.33	110
R	38.66	53.33	14.67	32.33	36.33	4	52.33
L	104	121.33	17.33	96.66	103.33	6.67	92
L	110.66	113.66	3	33.33	92.66	59.33	65
L	41.66	51	9.34	26.66	40	13.34	30.33
R	113.33	150	36.67	133.33	143.33	10	120
L	41	50	9	40	47.33	7.33	37.33
L	59.66	60.66	1	56.66	61	4.34	60.33
L	139.33	161.33	22	16.6	84.66	68.06	55
L	64	82.33	18.33	79.66	89	9.34	80.66
R	58.66	71.66	13	60	77.33	17.33	55.33
R	111.66	111.66	0	102	102	0	113.7

REFERENCES

Amadio, P.C., Bombardier, C., and the Upper Extremity Collaborative Group. (1996). Development of an Upper Extremity Outcome Measure: The DASH. American Journal of Industrial Medicine, v29, 602-608.

Ashford, R.F., Nagelburg, S., Adkins, R. (1995). Sensitivity of the Jamar Dynamometer in Detecting Submaximal Grip Effort. Journal of Hand Surgery, v21a, n3, 402-405.

De Domenico, G., Wood, E. C. (1997). Beard's Massage (4th ed.). (pp. 55-66). Philadelphia, PA: W.B. Saunders Company.

Harkonen, R., Harju, R., Alarante, H. (1993). The Accuracy of the Jamar Dynamometer. Journal of Hand Therapy, v6, 259-262.

Kendall, F. P., Kendall-McCreary, E., Repetitive Strain Injury. A Computer User's Guide. (pp. 89). New York, NY: John Wiley & Sons, Inc.

Kisner, C., Colby, L. A. (1996). Therapeutic Exercise: Foundations and Techniques (3rd ed., pp. 165, 238, 253). Philadelphia, PA: F. A. Davis Company.

Levine, D. W., Simmons, B.P, Koris, M. J. (1993). A Self-Administered Questionnaire for the Assessment of Severity of Symptoms and Functional Status in Carpal Tunnel Syndrome. Journal of Bone and Joint Surgery, v 75-a, n11, 1585-1592.

Lucas, L. A., Cushall, M. B. (1992). Computer Trauma. Print, v46, n3, 84-85.

Mathiowetz, V. (1985). Grip and Pinch Strength: Normative Data for Adults. Archives of the Physical Medicine and Rehabilitation, v66, n2, 69-74.

McClure, L. (1994). Thinking Ergonomics. Progressive, v58, n8, 40.

Meyer, M., Shackelford, L., Lee, C. S., Rogers, A., Gordon, J. (1995). Business: A Pain for Business. Newsweek, v125, n26, 42.

O'Sullivan, S. B., Siegelman, R. P. (1997). National Physical Therapy Examination Review and Study Guide (pp. 7, 171-172). Concord, MA: International Educational Resources.

Pascarelli, E., Quilter, D. (1994). Injury Sourcebook. (pp 1-95). Shreveport, LA: Lowell House, distributed by Contemporary Books.

Peddi, S., Rosenburg, C. H. (1997). The Repetitive Strain Provance, P. G. (1993). Muscles: Testing and Function, with Posture and Pain (4th ed.). (pp. 337-338). Baltimore, MD: Williams & Wilkins, A Waverly Company.

The Boston Women's Health Book Collective. (1991). Is Your Job Injuring You?. Ms. Magazine, v1, n4, 78-79.

Upper Extremity Collaborative Group. (1996). Measuring Disability and Symptoms of the Upper Limb: A Validation Study of the DASH Questionnaire. Arthritis and Rheumatism, v39, n9, 112.

Yassi, A. (1997). Occupational Medicine: Repetitive Strain Injuries. The Lancet, v349, n9056, 943-947.