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Effects of an Applied Kinesiology Technique on Quadriceps Femoris Muscle Isometric Strength

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The effect of either the muscle spindle cell receptor technique of applied kinesiology or a placebo technique on isometric strength of the right quadriceps femoris muscle group was studied among 20 normal human subjects. Peak, perpendicular maximal values of isometric quadriceps femoris muscle force was measured by a force transducer. Three training sessions consisting of three trials of peak maximal contractions of the isometric quadriceps femoris muscle were performed by all subjects. After the three training sessions, matched pairs of subjects were formed from a rank order list of each subject's mean values of isometric quadriceps femoris muscle strength on the third session. One subject of a matched pair was then randomly assigned to either an experimental (applied kinesiology) or control (placebo) group for the testing session. No significant differences in mean values of isometric quadriceps femoris muscle strength between the matched pairs for control and experimental subjects were noted. Within the context of a normal population, the applied kinesiology technique does not appear to augment isometric quadriceps femoris muscle strength.

Key Words: Muscle contraction, Exertion, Muscle tone.

Applied kinesiology is a new concept in the evaluation and treatment of musculoskeletal problems and is defined by Eversaul as

a concern with the dynamics of smooth and striated musculature, and the impact of those functions on structural entities, healing processes, and disease resistance. In particular, applied kinesiology focuses on the identification and correction of proprioceptive dysfunction of ligaments and of muscles' spindle cells and golgi tendons (Golgi tendon organs). Finally, applied kinesiology is concerned with the vascular, lymphatic, and other systems supporting proper muscle dynamics as well as the nutritional requirements for those support systems and muscles themselves.1

Since being introduced by Goodheart,2 (p. 3) applied kinesiology principles have been disseminated to a variety of health care providers. Chiropractors have used applied kinesiology on individuals with low back or knee pain or with temporomandibular joint dysfunction.3 Dentists have been presented with the principles of applied kinesiology for the evaluation and treatment of patients with temporomandibular joint dysfunction.1,4 Physical therapists and athletic trainers have been instructed in the concept of applied kinesiology through a continuing education course offered by Sopler.5 Favorable results, such as decreasing muscle spasm and increasing muscle strength, have not been documented, but have allegedly been obtained after the clinical use of applied kinesiology.1,3,4 Such favorable outcomes have been accomplished by performing one basic evaluation procedure followed by a variety of treatment procedures.1,3,4 Specifically, a muscle is determined "weak" either by muscle testing procedures developed by Kendall,6 or by exhibiting muscle spasm on palpation or visual inspection. Techniques advocated for strengthening this "weak" muscle have included the muscle spindle cell receptor technique (MSCRT) and golgi tendon organ receptor technique (GTORT).1,3,4 These techniques, performed sepa-
rately or in combination, allegedly strengthen the
“weak” muscles of individuals exhibiting neuromuscular disorders.\(^1\),\(^3\),\(^4\) These techniques are also presumed to increase muscle strength of normal individuals (Goodheart GJ, DC, personal communication of unpublished observations, December 1979).

Controlled experimentation has not been presented on any aspect of the MSCRT. The present study was therefore undertaken to address the following question: Does the MSCRT, performed under controlled conditions and specifically as described by applied kinesiologists, increase the strength of a normal quadriceps femoris muscle group? Clinical investigation of the strengthening effect of the MSCRT should help provide information that may benefit those clinicians who use the MSCRT.

METHOD

Subjects

The subjects for this study were 20 women between the ages of 22 and 34 (mean age, 28.5). None of these subjects had previous histories of acute or chronic orthopedic, neurological, or muscular diseases. Six subjects were regularly engaged in activities such as jogging, calisthenics, and stretching exercises for a period of three months to five years before participating in this study. The subjects were not permitted to exercise for eight hours before the testing of isometric strength. This requirement was necessary to decrease the effects of muscle fatigue on the results of the experiment. Fourteen subjects did not engage in any active exercise program during the experiment.

Positioning

Each subject was seated on a table to which a wooden seat with an adjustable backboard was affixed (Fig. 1). The seat and backboard provided a standard testing position of 110 degrees of hip flexion for each subject. Subjects’ arms were extended and placed along the sides of the table. A tongue depressor was positioned across the first molars to decrease the possible strengthening effects from jaw and teeth approximation, as suggested by Smith\(^7\) and Eversaul.\(^8\)

Stabilization was provided by an adjustable strap, secured to the backboard and pulled tightly above the anterior superior iliac spines of the pelvis. Additional stabilization was provided by a strap fastened to the seat and placed about 10 cm (4 in) above the left patella.

The right leg was arbitrarily selected for testing and placed at 60 degrees of knee flexion by positioning the foot upon the rung of a wooden stool. This angle of knee flexion was checked periodically during goniometric measurements. The left leg was allowed to hang freely.

Muscle Group Selection

The quadriceps femoris muscle was purposely selected as the target muscle group because this muscle group 1) is usually strong, 2) was used to measure isometric strength under controlled conditions,\(^9\),\(^10\),\(^11\) 3) was described to demonstrate any applied kinesiologic dysfunction rarely,\(^1\) and 4) was used to demonstrate the MSCRT by Walther.\(^2\) (p 21) The test joint angles were selected because 60 degrees of knee flexion with 110 degrees of hip flexion were reported to be optimal test positions for measuring maximal values of isometric quadriceps femoris muscle strength.\(^11\)

Measurement of Isometric Quadriceps Femoris Muscle Strength

Isometric force of the quadriceps femoris muscle was produced as the subject pulled upon a cuff, which was placed directly superior to the medial and lateral malleoli (Fig. 1). The cuff was connected to a force transducer,* which in turn was attached to a chain secured to different sites beneath or on the table. A 90-degree angle was formed between the ankle and the force transducer as measured by a standard universal goniometer. This method ensured that a perpendicular isometric force was obtained. Connections to the force transducer were adjusted to maintain the 90-degree angle by two separate methods. The selection of either method was determined by the height of the subject. If the subject was taller than 165 cm

* Type 5001, Kistler Instrumente, AG CH-8408, Winterthur, Switzerland.
(65 in), an S hook, located on one end of the chain, was moved along a sequence of eyebolts. The eyebolts were positioned 2.54 cm (1 in) apart upon a horizontal board, which was stabilized by the table. If the subject was shorter than 165 cm, the S hook was placed into an eyebolt, located within another wooden board. This wooden board was secured onto the front of the table by two “C” clamps and was adjusted vertically by moving the two “C” clamps up or down along the legs of the table. The peak force generated by the subject through these arrangements was displayed on an oscilloscope.‡ The scale of measurement permitted observation of the force displayed on the oscilloscope accurately to within 0.45 kg (1 lb).

Definition and Application of MSCRT

The MSCRT is described as a manually applied intermittent tugging pressure, simultaneously performed upon two “muscle spindle areas.”¹,²,³,⁴ The two “muscle spindle areas” are along the midline and the center of the quadriceps femoris muscle belly.⁹ One area is located toward the insertion of these muscles and the other area, toward the origin. Application of the MSCRT upon a normal muscle involves the production of 0.9 to 2.7 kg (2–6 lb) of downward pressure with each thumb upon each “muscle spindle area” of a noncontracting target muscle (Goodheart, personal communication). Each muscle spindle area is then intermittently tugged away from the other, along the axis of pull of the target muscle¹,²,³,⁴ (Fig. 2). Optimal frequency and duration of a MSCRT treatment has not been documented, but a 30-second duration has been recommended (Goodheart, personal communication).

In this present investigation, the MSCRT technique was performed in the following manner. The subject was comfortably seated in the test position. Two force transducers,‡** each with an application point corresponding to the dorsal surface of the right thumb of the investigator (about 8 cm², or 1.24 in²), were used to quantify application of these techniques (Fig. 1). The MSCRT and the placebo techniques were administered manually through force transducers. One area for placement of a force transducer was over the rectus femoris muscle 25 cm (9.8 in) below the anterior superior iliac spine. The area for the other force transducer was located 10 cm (3.9 in) above the superior pole of the right patella and along the same muscle.

Perpendicular force, applied manually through one force transducer, was displayed on an oscilloscope.†† This oscilloscope was calibrated for forces from 0 to 4.5 kg (9.9 lb). A range from 0.9 to 2.7 kg was marked with a grease pencil upon the screen of the oscilloscope. During performance of the MSCRT, the applied perpendicular force was maintained within this marked range. A perpendicular force of 0.9 to 2.7 kg applied through the other force transducer was visually monitored by observing the force on a digital voltmeter.‡‡ Gentle tugs were applied through the transducers along the skin surface at a frequency of one tug per second. During the application of the placebo technique, transducer tips were merely applied to the skin contact loci; no force was observed on either the oscilloscope or the digital voltmeter.

Calibration and Reliability

Force transducer calibrations were undertaken before each session. Applied forces were linear over the ranges used in this study. Stopwatches used to time procedures by the investigator and assistants, who were also physical therapists, were always within 0.1 second of one another.

The isometric force displayed on the oscilloscope was observed twice before being recorded independently by the investigator and the assistants. These observations were compared and considered reliable only if recordings were identical for both the investigator and the assistants. All goniometric measurements were taken twice before the subject performed an isometric contraction. All goniometric measurements were also randomly checked by the assistants throughout the experiment. Goniometric measurements were considered reliable between the investigator and the assistants if these measurements were within ±3 degrees of each other. The areas located on the right rectus femoris muscle and designated for

† Model 5103N, Tektronix Inc, Beaverton, OR 97077.
‡ FT 10C Grass Instrument Co, Quincy, MA 02169.
** Laboratory constructed.
†† Model t912, Tektronix Inc, Beaverton, OR 97077.
‡‡ Model 2800, Data Technology, 2700 S Fairview, Santa Ana, CA 97204.
applying the MSCRT or placebo technique were measured by both the investigator and the assistants. A variation of ±5 mm between these measurements was acceptable.

**Scheduling**

Three training sessions followed by one testing session were administered to each subject. Three training sessions were selected to control for increases in isometric strength caused by the effects of "motor learning." Each subject was tested on the same two days for two consecutive weeks. Each subject also reported to each session within two hours of her originally scheduled time to control for diurnal effects on isometric strength.

**Experimental Procedure**

During the training session, the subject was asked to breathe normally, not to perform a Valsalva's maneuver, and not to bite down on the tongue depressor. The tongue depressor was examined for indentations after the subject performed each contraction. Each subject was asked to maintain a straight and erect head position. A peak maximal isometric contraction was defined as the maximal force developed by the subject during a five-second contraction. A three-minute rest period followed each of the three contractions. The subject was unable to observe the isometric force displayed on the oscilloscope during the sessions, and no results were discussed with the subject.

Following three training sessions, each subject's result was placed on a rank-order list from the "strongest" to the "weakest," based upon mean values of isometric quadriceps femoris muscle strength of only the third session. Matched pairs of subjects were formed from this rank-order list by first selecting the two "strongest" individuals and ending selection with the two "weakest" subjects. Each subject in a matched pair was then randomly assigned to either the experimental or control group for the fourth session.

During the testing session, the MSCRT was performed upon subjects of the experimental group, while a placebo technique was employed among subjects of the control group. Both the MSCRT and the placebo techniques were undertaken for 30 seconds, about one second before the subject performed an isometric contraction. Positional stabilization, commands, number of isometric contractions, duration of isometric contraction, and rest periods were identical to those of the training sessions.

The difference in the mean values of isometric quadriceps femoris muscle strength between matched pairs of subjects during the fourth session was analyzed using a paired $t$ test to determine significant differences between the control and experimental groups. Mean values of isometric quadriceps femoris muscle strength and standard error of the experimental and control groups for each session were also calculated to identify any observable differences in group mean values throughout the experiment.

**RESULTS**

Differences in mean values of isometric quadriceps femoris muscle strength between matched pairs of control and experimental subjects during the testing session were not significant. Only one matched pair of subjects had a remarkable difference (+15.70 kg, or 34.6 lb) in mean strength. All other matched pairs had differences ranging from -6.15 to 9.42 kg (-13.6-20.8 lb).

Inspection of the mean values of isometric quadriceps femoris muscle strength between the control and experimental groups during the training sessions and testing session revealed a relatively equal isometric strength between the groups in each session. Both groups demonstrated similar small increases in group mean isometric strength during all four sessions. The largest increase in group mean isometric strength was observed in both groups between the second and third training session. Large increases in mean isometric strength for either group could not be demonstrated during the testing session in comparison with the training session (Fig. 3).

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Fig. 3. Maximal mean values of isometric quadriceps femoris muscle force of the control and experimental groups during each session. The values illustrated represent the mean of a subject's three trials during each session. ▲ is a subject of the control group, △ is a subject of the experimental group, and ○ is the group mean isometric strength. The brackets represent one standard error above and below the group mean values.
Peak maximal values of isometric quadriceps femoris muscle strength of each control subject and experimental subject was different in each trial within a session and between sessions (Fig. 4). No distinct pattern within a single session of isometric contractions, such as the first contraction’s showing the greatest peak force generated, could be observed. In addition, the session for which the greatest peak force could be demonstrated varied among all subjects.

DISCUSSION

Isometric quadriceps femoris muscle strength did not increase significantly whether the subjects received a placebo or the MSCRT. The implication from this result is that the MSCRT, under controlled conditions and performed specifically as described by applied kinesiologists, does not significantly increase the strength of a normal muscle.

There are explanations for why the MSCRT did not produce an increase in strength. The conditions under which an increase in strength following application of the MSCRT as observed by Goodheart (personal communication) are unknown. Possibly the undocumented increase in strength that he observed was caused by the effects of “motor learning,” described by other investigators who examined changes in isometric strength. Increases in strength caused by “motor learning” were rarely observed in this study and were controlled, to some extent, by including the training sessions and by incorporating a control group. Motivation could have also caused the increase in strength observed by Goodheart. Motivation was controlled in this study by not discussing the results with the subjects and by not permitting the subjects to observe the isometric force displayed on the oscilloscope. Subjects’ motivation could have differed from session to session because of circumstances not controlled within this study or because of the subjects’ indifference with the repeated training procedures; yet my impression is that motivation levels appeared to remain high throughout the experiment.

Questioning the one matched pair, who demonstrated a difference in mean values of isometric quadriceps femoris muscle strength of +15.70 kg, did not reveal anything unique about their neuromuscular status or state of well-being. The factors that influenced the large difference between this matched pair are unknown.

Sample size might have influenced the results of this investigation. Although the sample was small, adequate information was obtained to interpret the results by using repeated measures and multiple sessions.

A major problem in explaining why the MSCRT did not influence muscle strength in this investigation was the lack of a clear, concise neurophysiological rationale. Goodheart implied that an increase in muscle strength presumably occurs because the MSCRT activates primary muscle spindle afferent fibers during stretching of the relaxed target muscle. This activation allegedly enhances the voluntary contraction of the homonymous muscle. But an entirely different set of assumptions is warranted, according to information available from microneurographic investigations of the muscle spindle primary afferent activity produced by certain mechanical stimuli to a relaxed muscle among normal human subjects. These investigations revealed the following qualitative and quantitative information: 1) mechanical stimuli, such as pressure, must be applied to a very small distinct receptive field to elicit any afferent activity, 2) a deep pressure must be applied to the muscle belly to produce an afferent response similar to the response evoked from stretching the muscle by passive movements, and 3) light touch applied to the skin overlying the muscle does not elicit any proprioceptive afferent activity. In comparing the mechanical stimuli used in the microneurographic studies to those used in the MSCRT, whether the MSCRT is applied to a small receptive field remains to be determined. An important consideration, however, is that only a light pressure is performed during the MSCRT. Also, a strong possibility exists that the MSCRT, as described by applied kinesiologists, does not stretch the muscle at all, but rather only displaces the subcutaneous tissue above the muscle. In all likelihood, the pressure or the absence of a stretch to the muscle belly during the MSCRT would not have elicited any microneurographic activity within the target muscle.

Given this perspective, it is highly improbable that mechanical stimuli administered during the MSCRT could adequately excite enough muscle spindle primary afferent fibers to produce the appropriate spatial and temporal input necessary to bring members of the homonymous motor neuron pool to discharge threshold. Whether the MSCRT can provide sufficient afferent fiber activation to depolarize motor
neurons to a level whereby greater motor output can be obtained during a volitional contraction is not known; however, the time interval between application of the technique and the command to contract the muscle volitionally (about 1 second) would make that possibility highly unlikely. The implication of the results of the present study and the information available in the literature suggest that proprioceptive input during MSCRT is probably incapable of facilitating the tension generated by voluntary isometric contraction in the underlying muscle group.

The results of this study further suggest that more investigation is necessary to understand the effects of the MSCRT. Development of a rationale to explain the effects of this technique and to understand the concept of applied kinesiology should be studied under controlled conditions. Microneurographic investigation during performance of the MSCRT should be explored. Future investigators of the MSCRT might consider using a larger sample size and testing a third group of subjects who do not receive any technique applications. These procedures might further clarify a neurophysiologic rationale for the MSCRT and must be undertaken before definitive statements about applications of the technique for patients with specific disorders can be made.

CONCLUSION

The MSCRT used by applied kinesiologists did not increase the strength of the quadriceps femoris muscle group among normal subjects. From a neurophysiologic perspective, proprioceptive input during the MSCRT apparently was incapable of facilitating the tension generated by voluntary isometric contraction in the muscle group over which the technique was applied.

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