Effects of Hamstring-Specific Exercise in Chronic Low Back Pain Patients and in Failed Back Syndrome Patients

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ABSTRACT. Gold K, Franklin C, North C, Sukup C, Keating C. Effects of hamstring-specific exercise in chronic low back pain patients.

Objective: To evaluate effects of hamstring strengthening on chronic low back pain patients and on patients with failed back syndrome.

Design: An analysis of patients who presented with chronic low back pain (no surgery) and failed back syndrome (postsurgical) and the effects of hamstring-specific exercise.

Setting: Clinic.

Patients: Twelve subjects (average = 38 years, 8 females and 4 males) with low back pain of greater than 8 months' duration evidencing 2 or more LPD concerns on exam. Nine subjects (average = 40 years, 5 females and 4 males) with prior back surgery and back pain of greater than 8 months' duration evidencing 2 or more LPD concerns on exam.

Main Outcome measures: Cross-over controlled study randomizing subjects to four weeks' use of modified knee orthosis (Protonics) during an eight week program of otherwise conventional therapy home exercises. Protonics was used for exercising hamstring muscles by adding resistance to knee flexion. Subjects were examined at four week intervals and assessed for changes in self reported pain, low back mobility, straight leg raise (SLR), hamstring and abdominal strength, and lumbopelvic dysfunction (LPD) score. The latter was defined as sum of pain or tightness with Thomas' and/or Ober's tests, sacroiliac provocation, supine trunk rotation or weakness on standing leg bend test.

Results: Self-reported pain levels in chronic low back pain patients decreased 13.9% with Protonics vs. 4.3% without, difference not-significant (NS) at $P>0.05$. Lumbar mobility improved 24.2% with vs. 1.8% decrease without ($P=0.041$). SLR improved 8.5% with vs. 0.3% ($P=0.036$). Hamstring strength improved 25.8% vs. 6.8% without ($P=0.003$). Abdominal strength increased 35.2% with vs. decrease of 1.7% ($P=0.053$). LPD score decreased 26.5% with vs. 16.8% without ($P=0.024$). In the failed back syndrome patients pain levels decreased 34.0% with Protonics vs. 5.8% without, difference NS at $P<0.05$ for two-tailed t-test. Lumbar mobility improved 22.1% with vs. 9.5% decrease without (NS). SLR improved 9.4% with vs. 2.0% ($P=0.004$). Hamstring strength improved 18.3% vs. 3.0% without ($P=0.009$). Abdominal strength increased 48.9% with vs. decrease of 24.2% ($P=0.033$). LPD score decreased 34.4% with vs. 6.9% without ($P=0.022$).

Conclusion: Hamstring-selective exercises improved lumbar mobility, SLR, abdominal and hamstring strength significantly, while decreasing lumbopelvic dysfunction and reported pain in low back pain patients with evidence of lumbopelvic dysfunction on exam.

Pain about the lumbopelvic junction is evident in many patients who have not responded well to conventional treatments and in patients who have not responded well to surgical treatment alone ("failed back syndrome"). These patients are often neurologically intact, but evidence weakness involving abdominal and hamstring muscles when respectively tested supine and prone. They generally demonstrate good hamstring strength when tested in a sitting position, but often have significant hamstring weakness and even cramping generated when tested prone. The association between an anteriorly-rotated or forward-tipped hemipelvis and lumbopelvic dysfunction (pain) is well-recognized among physical therapists as is the association between weak abdominal muscles and low-back pain. However, an association between effective hamstring function and healthy lumbopelvic alignment, or the ability to maintain optimal pelvic alignment (without regular, continued treatments) has not been described. A study was designed to evaluate the effects of hamstring-specific exercises in these patients.

There is an interplay between the back muscles and the hamstring muscles during forward body flexion and extension. These motions consist of lumbar flexion and pelvic rotation. Termed the lumbar pelvic rhythm, the motion patterns consist of simultaneous lumbar and pelvic motion.[1] Significant activity occurs in both muscle groups during both flexion and extension but with different timing.[1] Starting at full forward flexion, both muscle groups are inactive.[1] Then as extension begins, hamstring muscles are activated first and then paraspinal muscles until both muscles cease activity in the full upright position.[1] Participants with a history of low back pain were shown to exhibit greater lumbar motion and velocity during the beginning of extension.[2]

Subjects with stiff hamstring muscles studied, had greater strength loss, more pain, and greater muscle tenderness.[3] Individuals with a history of low back pain were found to have tighter hamstrings than those without previous back pain.[2] A surgical technique that lengthens hamstring muscles has been credited to improve hip flexion considerably.[4] It seems that more flexible persons are less susceptible to muscle injury.[3] Since lengthening hamstring muscles increases hip flexion it would seem that this may decrease muscle injury.

Because hamstring muscles and back muscles aid in the same motions, namely lumbar flexion and pelvic rotation, it seems possible that weakness in one, hamstrings, may result in increased work or strain on the other, back muscles. This clinical study attempts to investigate the relationship between hamstring muscle strength and low back pain.

Protonics (knee orthosis) was used to strengthen hamstring muscles in the patients studied. In the current literature, no study could be found that studied the use of Protonics for low back pain. Protonics use has been researched previously for knee joint conditions.[5,6] The effect of Protonics has been researched during gait.[7] Increased activity was shown in the lateral hamstrings but not the medial hamstrings, with Protonic use during gait.[7] This study investigates the use of Protonics to strengthen hamstring muscles to aid patients suffering lumbopelvic dysfunction and low back pain.

MATERIALS AND METHODS

Two groups, twelve subjects (average age 38 years – 8 females, 4 males) with no prior history of back surgery and nine subjects (average age of 40 years; 5 females, 4 males with prior back surgery who reported ongoing, disabling (modified Oswestry score > 50), low back pain completed a prospective, sequence-randomized, cross-over controlled, eight-week therapy program including four weeks of hamstring-specific exercises using a modified knee orthosis (Protonics). Study inclusion criteria included low back pain of greater than 8 months duration, and the presence of two or more physical examination findings suggesting lumbopelvic dysfunction (LPD; defined as pain or tightness on Thomas' test, Ober's test, sacroiliac provocation, isolated standing leg bend, or limitation in supine lumbopelvic rotation). Subjects were randomized to use the Protonics (exercise orthosis) during either the first four or last four weeks of the eight-week program as adjunctive therapy with their usual program (medication, physical therapy, etc.). Exclusion criteria included presence of recognizable confounding variables such as change in medication, epidural steroid or other injection(s), other changes in therapy, incidental injury or illness, or patient unwillingness to either start (or stop) using the device as prescribed. Protonics use was initiated on whichever side manifested the weakest prone hamstring curl, but was occasionally used on either side at the patient's and/or involved therapist's discretion.

Patients were examined at four week intervals, noting self-reported pain levels (using a modified version of the Oswestry Disability Questionnaire), total lumbar mobility (flexion, extension, and lateral side bending measures), combined straight leg raise (SLR), respective hamstring pull and abdominal strength measures, and total lumbopelvic dysfunction (LPD) score. The latter is based on the sum of the above-listed LPD tests, respectively using a score of "0" in the absence of pain or tightness, "1" for mild to moderate pain or tightness, and "2" for pain or tightness so severe that either (1) the patient was unable to perform the test, (2) the patient had residual discomfort in the test area after testing, or (3) the patient required additional help to perform the task. An independent medical examiner (blinded to subject's program and Protonics use) was employed to perform physical examinations at 4- and 8-week follow-up visits.

RESULTS

Changes in outcome measures during the four weeks of knee orthosis use were compared

(using two-tailed t-test) to those changes demonstrated during the four weeks without it.

In the group of chronic low back pain patients who never had surgery results were as follows. Self-reported pain levels decreased 13.9% with Protonics use vs. a 4.3% decrease without. Changes in pain level were non-significant (NS) at P.0.05 when compared to respective baselines. Total lumbar mobility improved 24.2% with Protonics vs. a 1.8% decrease without (P=0.041). Combined straight leg raise (SLR) improved 8.5% with use vs. 0.3% (P=0.036). Combined hamstring strength improved by 25.8% with Protonics vs. 6.8% without (P=0.003). Abdominal strength increased by 35.2% with vs. a decrease of 1.7% without (NS, P=0.053). Lumbopelvic dysfunction score decreased 26.5% with Protonics vs. 16.8% without (P=0.024).

In the group of failed back syndrome patients with prior back surgery results were as follows. Self-reported pain levels decreased 34.0% with Protonics use vs. 5.8% without. These changes were (NS) at (P>0.05) level when compared to respective baselines. Total lumbar mobility improved 22.1% with Protonics vs. 9.5% without (NS). Combined SLR improved 9.4% with vs. 2% without (P=0.004). Combined hamstring strength improved 18.3% with vs. 3.0% without (P=0.009). Abdominal strength improved 48.9% with vs. 24.2% without (P=0.033), and LPD score decreased 34.4% with Protonics use vs. 6.9% without (P=0.022).

DISCUSSION

Patients who presented to the clinic with low back pain and failed back syndrome were examined by a physician. Use of Protonics strengthened and decreased tightness in hamstrings, and increased lumbar mobility in both populations. These patients subsequently experienced less back pain and decreased lumbopelvic dysfunction. This study showed that effective hamstring function correlates with optimal lumbopelvic alignment.[8]

This study focused on the treatment of chronic low back pain in an eight week period through the use of dynamic hamstring exercise. Further study is recommended to follow these or other patients past the eight week period to realize if the results will hold over time or if more hamstring exercise is warranted. It is believed that this study indicates dramatic results in an eight week time frame. Positive clinical effects have been documented due to dynamic exercise of the low back muscles.[9] It would be pertinent to discuss the frequency, number of repitions, and resistance necessary for use of Protonics to aid chronic low back pain sufferers.

Back muscles relax at a point where much of total flexion and about half of pelvic flexion is left.[1] The hip extensors relax during forward flexion at the point where almost full flexion is reached.[1] During extension from a fully flexed position, hip displacement was prominent in the first one quarter of motion and spine displacement was predominant for the remainder of extension.[2]

Persons with a history of low back pain tend to use more lumbar motion than hip motion during the beginning of forward flexion.[2] Hamstring length has been found to affect lumbar and hip motion patterns in persons with low back pain history but not in healthy persons.[2] Individuals with increased SLR of greater than 10 degrees displayed altered lumbar and hip motion.[7] Patients with low back pain that underwent surgery to lengthen their hamstring muscles showed marked improvement in forward flexion.[4]

It is common to stretch hamstrings in patients with low back pain during rehabilitation.[2] The thought is to allow greater motion to occur at the hips to reduce stress on the lumbar spine.[6] Strengthening hamstrings with Protonics in this study is pertinent to treat patients with low back pain. What occurs may be that these patients have abnormally tipped hemipelvis and that the Protonics device allows the hamstring muscles to correct pelvic alignment closer to optimum. Optimum pelvic alignment may allow the hamstrings better leverage and therefore afford them the ability to assist back muscles to their maximum ability during extension. Optimum pelvic alignment as well as non-tight hamstring muscles (increased SLR) probably allows for forward flexion to occur while putting less stress on the muscles and other anatomy of the lower back.

CONCLUSION

Hamstring-selective exercises appear to improve lumbar mobility, SLR, and hamstring strength significantly, with a trend of augmented abdominal strength, decrease in lumbopelvic dysfunction and reported pain levels in the group of patients having not had prior back surgery.

Hamstring-selective exercises appear to improve SLR, abdominal and hamstring strength significantly, while decreasing lumbopelvic

dysfunction and reported pain in the group termed "failed-back" patients.

These data suggest that hamstring-selective exercises may help reduce impairment and weakness in both patient populations with residual lumbopelvic dysfunction findings on exam. Further study is recommended.

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