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Improvement in the Contraction of the Transversus Abdominis Following Lumbo-Pelvic Manipulation – A Case Study

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Abstract: *As a clinician, everyone undergoes a difficult time in clinical decision-making when attempting to apply a clinical prediction rule for manipulation (Flynn et al., 2002; Childs et al., 2004) to a patient with a history and physical examination consistent with clinical lumbar instability (Hicks et al., 2005). The effect on neural pathways associated with manipulation has been suggested as one possible mechanism that may improve muscle performance (Pickar, 2002) and patient symptoms. Support exists for an association between spinal manipulation and improved muscle function in the quadriceps (Suter et al., 1999), the erector spinae (Keller and Colloca, 2000), and the deep neck flexors (Sterling et al., 2001). Therefore, it is reasonable to hypothesize that spinal manipulation, by a reflexogenic mechanism, may improve the performance of the deep trunk stabilizers. In turn, improved relaxation and contractility of the lumbar multifidus and the transversus abdominis (TrA) theoretically could lead to improved functional stability of the spine through enhancement of the neurological and active subsystems as defined by Panjabi (1992a, b). This single case study describes changes observed in the TrA musculature pre- to post-manipulation in a patient that presented with a clinical paradox (symptoms suggestive of clinical lumbar instability but also meeting the clinical prediction rule to succeed with lumbar manipulation therapy). Real-time ultrasound imaging (USI) was used to describe the changes in the TrA musculature..*

Keywords: Lumbo-Pelvic Manipulation

I. INTRODUCTION

As a clinician, everyone undergoes a difficult time in clinical decision-making when attempting to apply a clinical prediction rule for manipulation (Flynn et al., 2002; Childs et al., 2004) to a patient with a history and physical examination consistent with clinical lumbar instability (Hicks et al., 2005). The effect on neural pathways associated with manipulation has been suggested as one possible mechanism that may improve muscle performance (Pickar, 2002) and patient symptoms. Support exists for an association between spinal manipulation and improved muscle function in the quadriceps (Suter et al., 1999), the erector spinae (Keller and Colloca, 2000), and the deep neck flexors (Sterling et al., 2001). Therefore, it is reasonable to hypothesize that spinal manipulation, by a reflexogenic mechanism, may improve the performance of the deep trunk stabilizers. In turn, improved relaxation and contractility of the lumbar multifidus and the transversus abdominis (TrA) theoretically could lead to improved functional stability of the spine through enhancement of the neurological and active subsystems as defined by Panjabi (1992a, b). This single case study describes changes observed in the TrA musculature pre- to post-manipulation in a patient that presented with a clinical paradox (symptoms suggestive of clinical lumbar instability but also meeting the clinical prediction rule to succeed with lumbar manipulation therapy). Real-time ultrasound imaging (USI) was used to describe the changes in the TrA musculature.

II. METHODS

The patient was a 43-year-old male with a 30-day history of right low back pain and diffuse, posterior right thigh pain to the knee. His symptoms had developed insidiously while running. He reported a history of mild recurrent low back pain for 10 years. The patient's most notable examination findings were a constant pain in the thigh and a painful catch

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in flexion and in extension. Upon screening for a concurrent research study, he was found to have signs suggestive of clinical instability. However, on examination, he was also noted to have four of five criteria that predict short-term success with spinal manipulation. The patient consented to receive USI both before and after spinal manipulation. 2.2. Pre-manipulation training A previously developed technique (Teyhen et al., 2005) was used to train an isometric contraction of the TrA muscle through the abdominal drawing-in maneuver (ADIM). The patient was first instructed in the ADIM via traditional training techniques (Richardson et al., 1999). The patient was instructed to gently pull his abdominals in toward his spine as he exhaled and then to maintain this contracted state for 10 s. The initial training also included tactile cueing with the patient's fingers palpating 1 inch medial and inferior to the anterior superior iliac spine to help confirm contraction of the TrA. After the patient understood the intent of the ADIM, he underwent training using real-time USI as biofeedback. In order to obtain a ceiling effect, training continued until the patient was able to perform three isolated TrA contractions with no further increase in the thickness of the TrA during the ADIM. The training session lasted for approximately 15 min. 2.3. Ultrasound instrumentation and measurement technique Ultrasound images of the lateral abdominal muscles were obtained both pre- and post-manipulation using the Sonosite 180 Plus (Sonosite Inc. Bothell, WA) with a 2–5 MHz curvilinear array in B mode. The patient was positioned in a supine crook-lying position. The transducer was placed approximately 1 inch superior to the iliac crest along the mid-axillary line in the transverse plane. Once an adequate image of the TrA was obtained, a skin marker (a single line bisecting the length of the transducer head) was used to standardize the location of the transducer between pre- and post-manipulation images. Measurements of muscle thickness of the TrA were obtained pre- and post-manipulation with the patient at rest and during the ADIM. To standardize the influence of respiration (De Troyer et al., 1990; Hodges et al., 1997; Hodges and Gandevia, 2000a, b) on the thickness of the TrA, the images were collected upon completion of the exhalation as determined by visual inspection of the ultrasound image. The procedures used to measure the muscle thickness of the TrA are described elsewhere (Teyhen et al., 2005). 2.4. Manipulation The manipulation performed was a regional lumbopelvic manipulation detailed elsewhere (Flynn et al., 2002; Childs et al., 2004). This regional technique was selected since it was the specific technique used to develop (Flynn et al., 2002) and validate (Childs et al., 2004) the clinical predictive rule criteria that matched our patient. The manipulation was attempted on the right side first but yielded no cavitation. The pkumatient was repositioned and the left side was then manipulated. Again, no cavitation was heard or felt. Finally, a repeat manipulation on the right yielded cavitation and the intervention was considered complete. The patient was immediately repositioned on the table and the post-manipulation measurements were captured using the previously described protocol. Care was taken to place the transducer head in the exact location that was used to capture the pre-manipulation images. 2.5. Data analysis The statistical significance of the changes in muscle thickness was analyzed by considering a previously reported standard error of the measure (SEM). The SEM for the measurement technique described was established to be 0.031 cm (Teyhen et al., 2005). Therefore, a significant change in muscular thickness was defined as a change greater than two SEMs (0.062 cm); thus the authors could be 95% confident that any change measured was due to an actual change in the phenomenon being measured and not measurement error. 3. Results Changes in the TrA function were noted immediately post-manipulation. The total rest-to-contract difference post-manipulation was 0.38 cm, nearly doubling the total rest-to-contract thickness premanipulation (0.21 cm). Our patient demonstrated a statistically significant change in all three measurements related to the TrA thickness: a decrease in resting thickness of the TrA, an increase in maximal thickness during the ADIM, and an increase in total rest-tocontract thickness of the TrA post-manipulation. The changes in muscular function noted after the manipulation were also accompanied by modest clinical improvements. The patient's painful catch moving into extension was abolished and his constant thigh pain became intermittent. However, his painful catch with forward bending was only transiently improved.

III. DISCUSSION

Our results document a dramatic change in one patient's ability to perform a preferential TrA contraction during an ADIM immediately following spinal manipulation. It is notable that the observed improvement occurred after an established ceiling effect in the performance of the ADIM was reached. This improvement in the ability to contract the TrA was also associated with improvements in some clinical exam findings. Manipulating a patient with a presentation suggestive of clinical instability appears counterintuitive. However, there exists the logical possibility that in some patients with clinical instability, a high-velocity, low-amplitude thrust procedure may be a reasonable treatment option. The relationship between the inhibition of primary muscular stabilizers and pain, joint dysfunction, and instability has already been demonstrated in the lumbar spine (Hodges and Richardson, 1996; Richardson et al., 2002; Hungerford et al., 2003). This concept has been extended to other regions including the cervical spine (Sterling et al., 2001), the shoulder (Magarey and Jones, 2003), and the knee (Suter et al., 1999; Cowan et al., Muscular thickness of the transversus abdominis (TrA); measured in centimeters Pre-manipulation Post-manipulation Difference Resting TrA 0.51 0.42 0.09* Max contract during ADIM 0.72 0.80 +0.08* Rest-to-contract difference 0.21 0.38 +0.17* Significance (*)42SEMs (0.062 cm); SEM ¼ standard error of the measurement; ADIM ¼ abdominal drawing-in maneuver. N.W. Gill et al. / Manual Therapy 12 (2007) 280–285 283 2001). Demonstrating a relationship between muscle inhibition and spinal manipulation, Suter et al. (1999) measured a decrease in quadriceps inhibition in patients with anterior knee pain after manipulation of the sacroiliac joint. Furthermore, Keller and Colloca (2000) used surface EMG activity to assess the isometric strength of the erector spinae post-manipulation and noted increased gains compared to a sham manipulation. Therefore, it is likely that a regional lumbopelvic manipulation could reduce muscle inhibition and/or facilitate optimal function of the intrinsic lumbar stabilizers via a reflexogenic mechanism; improved performance of the TrA and multifidus muscles would, in turn, result in improved stability to the spine. There is growing evidence that a combination of manipulation and lumbar stabilization is effective (Aure et al., 2003; Niemisto et al., 2003; Childs et al., 2004). This could be due, in part, to the potential for improved functioning of the TrA and multifidus muscles after manipulation. The immediate effect of manipulation may decrease pain, restore motion, and reset the neural control and active (muscle) subsystems. This would facilitate the training of isolated TrA and multifidus contractions. In essence, the manipulation would provide a neurophysiological ‘‘window of opportunity’’ to maximize the effectiveness of the first phase of lumbar stabilization. This is then followed by advanced and functional lumbar stabilization training to facilitate motor re-patterning for the long-term rehabilitative and preventive effect (O’Sullivan et al., 1997, 1998; Hides et al., 2001). A similar suggestion (application of mobilization prior to muscle retraining) has been suggested by Sterling et al. (2001) in the retraining of the deep neck flexor muscles. Direct support for this theory was measured in a recent trial by Childs et al. (2004) in which those patients receiving two manipulations and simple motion exercises during the first week followed by 3 weeks of lumbar stabilization exercises experienced greater improvement in short-term and long-term function than those receiving lumbar stabilization exercises alone. Threats to internal validity abound in a case study and therefore it is not possible to ascribe any changes documented here to a cause and effect relationship. Training effect is one significant threat in this case study but the training effect was mitigated by imaging the lateral abdominal muscles pre-manipulation after a ceiling effect was noted. Furthermore, the proximity of the pre- and post-measurements helps to minimize the influence of a training effect. The authors are currently investigating the effects of manipulation on motor control of the TrA and the multifidus using a randomized control trial. It is important to note that the patients of interest are those with signs of clinical instability and not those with frank or gross instability.

IV. CONCLUSION

In this single case study of a patient with symptoms suggestive of clinical instability, improvement in the contraction of the TrA was found immediately following a regional lumbo-pelvic manipulation. It is theoretically feasible that the manipulation provided a neurophysiological ‘‘window of opportunity’’ in which to maximize the preferential activation of the key spinal stabilization muscles. Future researchers should investigate the effects of manipulation on neuromuscular control of the deep trunk muscles and on symptoms suggestive of clinical instability.

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