Complementary Therapies in Medicine (2014) 22, 235—243

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevierhealth.com/journals/ctim

Core muscle function during specific yoga poses

Meng Ni[a], Kiersten Mooney[b], Kysha Harriell[a], Anoop Balachandran[a], Joseph Signorile[a,*]

[a] *Laboratory of Neuromuscular Research and Active Aging, University of Miami, Coral Gables, FL, United States*
[b] *BalaVinyasa Yoga, Naples, FL, United States*
Available online 4 February 2014

KEYWORDS
Electromyography;
Yoga;
Rehabilitation

Summary
Objective: To assess the potential use of 11 yoga poses in specific training and rehabilitation programs via examination of the muscle activation patterns in selected trunk and hip muscles.
Design: Repeated-measures descriptive study.
Setting: University laboratory, US.
Participants: : Thirty healthy yoga practitioners with more than 3 months yoga practice experience (mean age ± SD, 32.0 ± 12.3 y; 8 M/22 F) participated.
Interventions: : Surface electromyographic signals of upper rectus abdominis, lower rectus abdominis, longissimus thoracis, external oblique abdominis and gluteus maximum muscle were recorded in 11 yoga poses: Halfway lift, Forward fold, Downward facing dog, Upward facing dog, High plank, Low plank, Chair, Mountain with arms down, Mountain with arms up, Warrior 1 (both sides).
Main outcome measures: : Root mean square values of each muscle during each pose, normalized by the maximal voluntary contraction.
Results: There were significant main effects of pose ($p < .001$) and muscle ($p < .001$), and a significant pose × muscle interaction ($p = .001$). The post hoc analysis revealed unique patterns for the five muscles of interest for each of the 11 poses ($p < .024$).

Abbreviations: EMG, electromyography; RAU, upper fibers of rectus abdominis; RAL, lower fibers of rectus abdominis; LT, Longissimus thoracis; EOA, external oblique abdominis; GM, gluteus maximum; MVC, maximum voluntary contraction.

* Corresponding author at: Department of Kinesiology and Sport Sciences, University of Miami, 1507 Levante Ave, Rm MO114, Coral Gables, FL 33146, United States. Tel.: +1 305 284 3105; fax: +1 305 284 4183.
E-mail address: jsignorile@miami.edu (J. Signorile).

0965-2299/$ — see front matter
http://dx.doi.org/10.1016/j.ctim.2014.01.007

Conclusions: Variations in core muscle firing patterns depend on the trunk and pelvic positions during these poses. Training programs can be developed by choosing particular poses to target specific core muscles for addressing low back pain and declines in performance. The High plank, Low plank and Downward facing dog poses are effective for strengthening external oblique abdominis, Chair and Warrior 1 poses for targeting gluteus maximum, and Chair and Halfway lift poses for strengthening longissimus thoracis. And these three muscles could be strengthened by the Upward facing dog pose.

The core, or the lumbopelvic-hip complex, acts as an anatomical and functional linkage for the transfer of force from the distal segments throughout the body.[1] The core is composed of a number of muscles, and strengthening these muscles is critical for providing local and global stabilization of trunk.[2] More precisely, the hip muscles support the trunk structures and play a significant role in force transfer from the lower extremity upward through the spine.[3] Muscular atrophy of the paraspinal muscles,[4,5] excessive loads on the lumbar spine,[6] poor endurance[7] and imbalance of hip extensors[8] are associated with back injuries and lower extremity instability. Core stability is also an important component for enhancing athletic performance[9] and reducing the probability of back injury,[10] improving functionality,[11] and augmenting responses to training and therapy.[12]

Strengthening and stabilization exercises have been utilized to increase core strength and stability, decrease spinal and pelvic viscosity, and facilitate motor patterns.[10] Several intervention studies have demonstrated the positive effects of core training on pain attenuation[13,14] and performance.[15] In addition to more traditional techniques, alternative conditioning methods such as Tai Chi, yoga and Pilates have also been employed.[16]

Yoga, originated in ancient India, aims to improve health conditions and address a wide range of health issues. The practice of yoga poses, or asanas, was developed as an approach to align, strengthen, and balance the structures of body.[17] Yoga asanas consist of the basic positions of standing, sitting, forward bend, back bend, twisting, inversion, and lying down. Although yoga has been used to enhance dynamic control of the stabilizing muscles and reduce lower back pain[18] through increased hip[19] and spinal flexibility,[20] the muscle activation patterns employed during specific yoga poses have yet to be investigated. Of special interest in the current study were the Vinyasa poses most commonly used to increase trunk muscle strength and balance, thereby improving stability and maximizing kinetic chain interactions between the upper and lower extremities.[21]

The objective of this study was to assess the potential use of 11 yoga poses in specific training and rehabilitation programs via examination of the muscle activation patterns in selected trunk and hip muscles. We hypothesized that different poses would produce unique variations in core muscle activation patterns that could provide guidelines for designing exercise prescriptions for training and rehabilitation.

Methods

Participants

A total of 30 yoga practitioners participated in the study (8 men, 22 women; mean age $\pm$ SD, 32.0 $\pm$ 12.3 y; mean weight $\pm$ SD, 62.3 $\pm$ 8.1 kg; mean height $\pm$ SD, 1.68 $\pm$ .075 m). Subjects were recruited on a voluntary basis through fliers, and personal contacts at yoga studios and wellness centers. The initial criterion for inclusion into the study was that the individual must have practiced yoga for more than three months or possessed a yoga instructor certification. Additionally, subjects must have participated in yoga training at least one time per week for at least three months, and must have been capable of completing the yoga sequence used in this study without assistance. Individuals with musculoskeletal and neurologic impairments, or existing or unresolved injuries that would limit movement in any way, were excluded from participating in this study. The length of time the subjects in our sample had been practicing yoga was 5.7 $\pm$ 5.5 years. All participants were informed of experimental procedures and completed a written consent approved by the University's Subcommittee for the Use and Protection of Human Subjects. A power analysis using an effect size of 0.25, an α value of 5% and a power of 95% yielded a minimal sample size requirement of 20.

Procedures

When the subjects arrived at the laboratory, they were asked to complete the consent form and health questionnaire. They were then allowed to warm up by performing the Vinyasa (breath synchronized movement) Yoga Sun Salutation A three times and Sun Salutation B twice at a self-determined pace. Following the warm-up, electrodes were placed on the skin over the muscles of interest on the participant's dominant side (27 right handed/3 left handed). A total of 5 muscle groups were tested, upper fibers of rectus abdominis (RAU), lower fibers of rectus abdominis (RAL), longissimus thoracis (LT), external oblique abdominis (EOA) and gluteus maximum (GM) muscle. To allow normalization of electromyography (EMG) data across subjects and collection days, 3 s maximal voluntary contractions (MVC) targeting each muscle were performed and EMG data from that muscle were collected. Following preparation and