Breathing & Orthopedics: More linked than you think!

Combined Sections Meeting 2016
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COURSE DESCRIPTION

The respiratory system is often overlooked as a contributing factor of movement dysfunction in the orthopaedic setting. However, there is a significant body of evidence linking breathing pattern disorders and deficient strength and endurance of the respiratory muscles with spinal pain and movement dysfunction. The speakers will summarize this growing body of literature and use their active research to describe the histological, biochemical, neuromuscular, and biomechanical rationale for assessing and treating the respiratory system in patients with orthopaedic conditions.

COURSE OBJECTIVES

Upon completion of this course, you will be able to:

1. Describe the pathophysiology of how impairment of the respiratory system leads to abnormal musculoskeletal function
2. Describe the abnormal biochemical findings and neuromuscular dysfunction of the respiratory system associated with chronic conditions such as spine pain and incontinence
3. State how the mechanics of breathing, talking, postural control and continence are inter-active and inter-dependent components of normal movement strategies using a soda-pop can as a conceptual model.
4. Discuss the potential benefits of utilizing inspiratory muscle training to treat chronic spine pain and enhance musculoskeletal performance

OUTLINE

Introduction (Speaker: Marlon Wong)

A. The relationship of breathing pattern dysfunction and chronic spinal pain
   a. Clinical relevance and overview of existing literature
   b. Underlying theories and paradigms for these associations
      i. Diaphragm as a key muscle for respiration, postural control, and visceral function
      ii. Respiratory induced changes in biochemistry affects neuromuscular physiology
      iii. Breathing is controlled by ANS, but is under both voluntary and involuntary control thus providing the primary mechanism through which humans can manipulate ANS function
B. Biochemical and ventilatory variables
   a. The role of CO₂
   b. Defining breathing pattern
      i. Respiration rate, tidal volume, and minute ventilation
      ii. the coefficient of variation
   c. Neuromuscular implications of breathing pattern dysfunction
      i. End tidal CO₂ (PetCO₂) and body pH
   d. Postural stability (static and dynamic) Inspiratory muscle training for spinal pain
i. LBP
ii. Ankylosing spondylitis
iii. Cervical pain

C. ANS implications
   a. Immediate effects of manual therapy on breathing in healthy subjects
   b. Breathing as a potential mediator of psychosocial risk factors and physiologic response to therapy

**Biomechanical Factors (Speaker: Mary Massery)**

A. Breathing issues exist in both pediatric and adult populations
   a. Beyond lung diseases
   b. Beyond orthopedic conditions
   c. Multiple body system interaction

B. Pressure
   a. Optimizing breathing mechanics and postural control involves coordinating pressure changes in the abdominal and thoracic cavities.
      i. The patient must be able to generate, maintain and regulate trunk pressures in order to simultaneously provide breath support and upright postural control.
   b. Present “soda-pop can” model of postural control
      i. Three horizontal trunk valves: vocal folds, diaphragm, pelvic floor
      ii. These 3 valves work in concert with chest, abdominal and back muscles to regulate pressures according to postural demand and respiratory demand.
   c. Diaphragm
      i. It is not a “respiratory” muscle.
      ii. It is the body’s major pressure regulator that supports: respiration AND postural stability, GI motility, support for lower esophageal sphincter to prevent reflux, and aids in venous return.
   d. What are normal intra-abdominal (IAP) and intra-thoracic pressures (ITP) at rest and with activity?
      i. IAP
         1. Always positive. Can’t be negative.
         2. +5-7 cm H2O at rest in supine
         3. increases 3-fold in upright (16-20 cm H2O)
         4. increases with activity level to meet postural demand
         5. increases with obesity and other excessive forces
      ii. ITP
         1. Vacillates from negative to positive pressure with every breath
         2. +/- 3 cm H2O at rest in supine
         3. Can increase transiently for deep inspiratory effort (greater negative pressure) or for forceful expiratory effort (greater positive pressure).
   e. What happens to postural alignment and postural control with non-optimal pressure support?
      i. Too little pressure: spine and chest collapse (i.e. neuromuscular conditions)
      ii. Too much pressure: hyper-expansion of chest and thoracic spine and possible injury to pelvic floor and/or vocal folds (i.e. obstructive lung disease conditions, some sports)
   f. New definition of core stability
i. Core stability extends from the vocal folds on top to the pelvic floor on the bottom and includes every muscle in between!

ii. In other words, you CANNOT assess, nor treat, breathing issues separately from postural control issues as they involve the SAME muscles!

C. Research supporting pressure management (“soda-pop can”) approach to breathing and postural control
   a. Presentation of seminal research from Hodges 2000 and Smith 2006, linking the diaphragm to postural stability and pelvic floor, and the implications to health and function.
   b. Presentation of current research building upon this research. Applying concepts to multiple other disease populations.
   c. Presentation of my research on the role of the vocal folds/glottis on postural stability (Massery 2013).

D. Treatment suggestions (Quick introduction)
   a. Treatment research is just emerging. How do we apply these principles now?
   b. Ventilatory strategies: applying breathing strategies to optimize movement
      i. Analyze thoracic spine movement in the desired motor task:
         1. Thoracic extension is anatomically paired with inhalation
         2. Thoracic flexion is anatomically paired with exhalation
         3. For example, an overhead volleyball serve would include inhalation when throwing the ball up and reaching arm up (thoracic extension), while exhalation would be coordinated with the serve itself (thoracic flexion).
      ii. Analyze the trunk muscle contraction necessary to achieve the desired motor task
         1. Isometric vs. isotonic
         2. Concentric vs eccentric
         3. Pair inspiratory or expiratory pattern with spinal movement above.
         4. For example, both the phases of the volleyball serve are isotonic, so trunk strategy and breathing strategy should be isotonic as well. In addition, both phases require concentric trunk movements, so inhalation will be a concentric upper chest inspiratory effort followed by a concentric (forceful) expiratory effort which could include grunting.
      iii. Add sensory strategy
         1. Visual
            a. Eyes up – inhalation
            b. Eyes down – exhalation
         2. Auditory
            a. Louder, faster, higher pitch – upper chest (accessory muscle) breathing
            b. Softer, slower, lower pitch – diaphragm breathing
      iv. Mix all together to optimally match breathing with postural control demands
         1. Obviously, any intervention needs to be fine-tuned to each patient, but these principles will give you a starting point for determining the appropriate breathing.

E. Suggestions for future studies and applications of concepts to orthopedic conditions as well as medical conditions (adults and pediatrics).

The Influence of Lifestyle, Habits, & Disease on Respiratory Muscle Performance – Functional, Physiologie, & Histologe Effects (Speaker: Larry Cahalin)
A. Respiratory muscles
   a. Inspiratory muscles
   b. Expiratory muscles
B. Respiration
   a. Inhalation and exhalation
   b. Cellular respiration
C. Measurement of respiratory muscle performance
   a. Observation, palpation, chest wall motion
   b. Measurement of pressure generated during inhalation and exhalation
      i. Manometry and electronic pressure transducers
      ii. Maximal Inspiratory Pressure (MIP)
      iii. Maximal Expiratory Pressure (MEP)
   c. Test of Incremental Respiratory Endurance (TIRE)
      i. Maximal Inspiratory Pressure (MIP)
      ii. Sustained Maximal Inspiratory Pressure (SMIP)
      iii. Inspiratory duration
D. The influence of life – “aging” – on respiratory muscle performance
   a. Gender differences
   b. SMIP and inspiratory duration
E. The influence of lifestyle, habits, and repeated tasks on respiratory muscle performance
   a. Health status
   b. Exercise
   c. Sport specific tasks in baseball
      i. Glenohumeral motion
      ii. Hip motion
   d. Swimming versus running
      i. MIP
      ii. SMIP
      iii. Inspiratory duration
   e. Inspiratory Muscle Training (IMT) in recreational runners
F. The influence of disease on respiratory muscle performance
   a. Muscle fiber type change due to disease
      i. Type I muscle fibers
      ii. Type II muscle fibers
   b. Heart failure
      i. MIP
      ii. SMIP
      iii. Inspiratory duration
   c. Inspiratory Muscle Training (IMT) in heart failure
G. Orthopedic concerns related to respiratory muscle performance and:
   a. Life
   b. Lifestyle and habits
   c. Repeated tasks
   d. Disease
H. Inspiratory Muscle Training in Cervical Pain or AS
REFERENCES:


