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Chapter 2: The Mechanics of Movement

Multiple Choice

1. Which of the following is the best definition of *center of mass (CoM)?*
A. The balance point of an object
B. The direction of movement when weight is added
C. The point directly behind the gravity pull
D. The push or pull that modifies movement

ANS: A
Rationale: CoM is the balance point of an object.

2. When considering how the concept of CoM affects your patient's movement, which of the following statements is true?
A. *Center of pull* is another term for CoM.
B. Each body part, such as a leg or an arm, has its own CoM.
C. The whole body has a CoM that cannot be localized.
D. When weight is added to the body, the CoM moves away from the added weight.

ANS: B
Rationale: Each body part has its own CoM. The body's CoM is anterior to S2. When weight is added to the body, the CoM moves toward, not away from, the added weight.

3. Which of the following is an example of an internal force commonly used when assisting patients with movement?
A. Ankle weights
B. Friction
C. Gravity
D. Muscular tension

ANS: D
Rationale: Muscular tension is the only option that is an internal force. The other options are external forces.

4. Which of the following statements regarding vectors and representation of movement forces is true?
A. For internal forces, the tail of the arrow lies at the muscle attachment on the moving lever of the muscle exerting the force.
B. Gravity is only depicted as a vertical arrow with the tail of the arrow originating behind a point at about S2.

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C. Muscle contraction force is depicted with an arrow pointing opposite to the combined effect of the muscle fibers.
D. The arrow on the vector is straight and points in the direction away from force exertion.

ANS: A
Rationale: For internal forces, the tail of the arrow lies at the attachment of the muscle exerting the force. When depicting gravity, the arrow tail is at the CoM of the object being affected; S2 is not the only point of origin. To depict muscle contraction force, the arrow points in the same direction as the combined effect of the muscle. The arrow on the vector points in the direction in which the force is exerted.

5. Which statement regarding levers in movement is true?
A. An axis of movement and a single source of force are required to establish a lever.
B. For a basic lever, usually there are two external or two internal forces.
C. In the human body, levers usually involve a single force and axis of motion.
D. Levers are utilized in the body when an external force is countered or controlled by muscle force.

ANS: D
Rationale: Levers are utilized in the body when an external force is countered by muscle force. Two sources of force are required for a lever. For a basic lever, there is usually one external force and one internal force. Several forces and axes, not just one, are usually involved in movement.

6. The primary reason we are interested in biomechanics as rehabilitation therapists is that
A. understanding biomechanics will ensure that we do not sustain common injuries affecting the lower back.
B. we need to be able to explain moment and lever arms to our patients.
C. we need to know how to move twice our own body weight safely.
D. we need to be able to apply biomechanical principles to assist patients safely and efficiently.

ANS: D
Rationale: Therapists must assist patients safely and efficiently. Having an understanding of and applying good biomechanics can reduce the risk of injury but does not entirely prevent back injuries. Complex concepts, such as moment and lever arms, are not typically explained in detail to patients. Biomechanics is not just about moving patients larger than we are.

7. Which of the following force-couple applications is less than optimal for patients to use when preparing to transition from sitting to standing?
A. Leaning forward and pulling up with both arms supported on the walker
B. Leaning forward and using the hip and thigh muscles to achieve liftoff
C. Pushing the upper trunk into the back of the chair while sliding the pelvis forward
D. Shifting from side to side to walk the hips forward to the front of the chair

ANS: C
Rationale: Pushing the upper trunk into the back of the chair while sliding the pelvis forward actually results in an increased moment arm and therefore requires more muscle force to bring the trunk forward into flexion. Leaning forward and pulling up with both arms supported on a walker does not describe a

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typical force couple. Leaning forward and using the hip and thigh muscles to achieve liftoff is an effective force couple. Shifting from side to side to "walk" the hips forward to the front of the chair is an effective, though less frequently used, method of moving forward.

8. If your patient has developed muscle atrophy while on a ventilator in the ICU, what is the most likely cause?
A. The appropriate amount of load applied to the tissues
B. Too little load applied to the tissues
C. Too much load applied to the tissues
D. Repeated rapid load to the tissues

ANS: B
Rationale: Atrophy is a sign of inadequate load to the tissues.

9. You are preparing to transfer a patient who just had bilateral knee replacements from the bed to the bedside chair. The patient is much taller than you are, and you want to make sure that the transfer is safe for you and the patient. As you face the patient, you determine that blocking both knees is not required. Which of the following positions is the *best* way to position your feet?
A. Place your feet about 10 in. apart and staggered.
B. Place your feet about 20 in. apart and side by side.
C. Place your feet about 30 in. apart and staggered.
D. Place your feet about 40 in. apart and side by side.

ANS: C
Rationale: Placing your feet about 30 in. apart provides a wide base of support (BoS). Staggering the feet allows for effective weight-shifting while maintaining good posture.

10. Which of the following would be most effective in promoting stability during patient-care activities?
A. Increase the distance of the CoM above the BoS.
B. Minimize the BoS
C. Position the line of gravity (LoG) posterior to the BoS.
D. Position the LoG near the center of the BoS.

ANS: D
Rationale: The LoG should be near the center of the BoS. You want to decrease the distance between the CoM and the BoS, not increase it. You want the BoS in a greater, not a smaller, area.

11. Which of the following factors is key to preserving dynamic trunk stability?
A. A neutral pelvis
B. Decreased or reduced lumbar lordosis
C. Extension of the hips
D. Flexion of the spine

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ANS: A
Rationale: A neutral pelvis is considered to be the safe or neutral zone for the lumbar spine. The other options do not refer to dynamic trunk stabilization techniques.

12. Your patient has been in bed for the past 7 days with a case of acute pneumonia. You are going to help her stand for the first time since she became sick. Which of the following muscle actions will be needed for the patient to successfully stand?
A. The back extensor muscles must be able to counteract inertia.
B. The hip extensor muscles must be able to control the LoG.
C. The knee extensor muscles must be able to counteract gravity.
D. The knee flexor muscles must be able to control the CoM.

ANS: C
Rationale: The knee extensor muscles are the primary movers in the effort to counteract the pull of gravity. Although the back extensors are working, they are not primarily counteracting inertia. Likewise, the hip extensors and knee flexors are active, but not necessarily to control the LoG or CoM.

13. To understand the fundamental principles of movement, it is most important to know which of the following?
A. The amount of ground reaction force in Newtons
B. The direction of force application
C. The distance between the CoM and the BoS
D. The exact measure of inertia to be overcome

ANS: B
Rationale: Knowing the direction of force application helps to make clinical judgments related to patient movement.

14. The concept of momentum is derived from Newton's Second Law of Motion. In which of the following scenarios is momentum *most* likely to be an element that needs to be controlled?
A. A patient is bridging in the bed to scoot to the right.
B. A patient is rolling from his back to his right side.
C. A patient is transferring from the floor to standing using a chair for support.
D. A patient is walking with crutches and a full leg cast.

ANS: D
Rationale: A patient walking with crutches and a full leg cast is the most likely scenario in which momentum forces need to be controlled. The forward swing of the involved leg generates momentum. The added weight of the cast increases the forward momentum. If uncontrolled, the momentum will pull the patient forward beyond his or her BoS, causing a fall.

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15. Your patient just had surgery on her right knee to repair an injury she sustained while playing volleyball. The physician has ordered “open chain” exercises. Which of the following activities would be most appropriate for this patient?
A. Mini–wall squats with the right foot up on a step
B. Sitting on the mat and straightening the right knee
C. Knee flexion and extension with resistance tubing while standing on the tubing
D. Supine bridging with both legs

ANS: B
Rationale: Sitting on the mat and straightening the knee is the only activity in which the foot is not stabilized. The other options are closed chain activities.

Matching

Match the following terms to their definitions.
A. Pulling that tries to stretch or lengthen tissue
B. The amount of force across a given area
C. The force applied to a given area
D. Twisting force about a structure’s axis
E. Two opposite direction forces, parallel to contacting surfaces

16. Pressure
17. Shear
18. Stress
19. Tension/tensile forces
20. Torsion

16. **ANS: D**
17. **ANS: A**
18. **ANS: C**
19. **ANS: E**
20. **ANS: B**

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