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Gluteus Muscle Function and Strengthening - A Practical Assessment and Application

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Introduction

As one of the largest and strongest muscle groups in the body, the gluteal muscles play a key role in a range of activities, from maintaining proper upright posture to explosive high-level athletics. Physical therapists and physical therapist assistants will encounter a range of disorders related to gluteal dysfunction in clinical practice. Therefore, clinicians must have a thorough understanding of the structure, function, and treatment of impairments relevant to the gluteal muscles. This course will provide the physical therapist and physical therapist assistant with a review of relevant anatomy and physiology, a discussion of key components needed during examination to properly identify gluteal impairments, an overview of common compensations related to gluteal weakness and dysfunction, and provide a framework for treatment and exercise selection.

Learning Objectives

1. Understand gluteus muscle function and recognize common compensations present due to weakness in various functional tasks.
2. Choose the correct tests and measures needed to distinguish between gluteal impairments.
3. Identify appropriate exercises and interventions for strengthening the gluteal complex based on impairments present.

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Section 1: Anatomy, structure, and function

The gluteus muscles, commonly referred to as the glutes, are a group of muscles composed of the gluteus maximus (glute max), gluteus medius (glute med), and gluteus minimus (glute min). Gluteal strength is important for proper posture, normal gait patterns, injury prevention, athletic performance, and reduction of pain. As powerful hip extensors and hip rotators, the gluteal complex is one of the largest and strongest muscle groups in the body. This section of the course will cover anatomical review of each gluteal muscle and provide an overview of structure and function.

Anatomy [5, 17, 20]

Collectively, the gluteal muscles make up the region commonly known as the buttocks. They are located on the posterior side of the pelvis, near the proximal end of the femur.

Understanding anatomical origin and insertion is key to understanding the action of each muscle.

Gluteus Maximus

- Origin: posterior gluteal line, sacrum, coccyx
- Insertion: IT tract, gluteal tuberosity
- Innervation: inferior gluteal nerve (L5, S1, S2)
- Function: hip extension, hip external rotation

Gluteus Medius

- Origin: external surface of ilium
- Insertion: greater trochanter of the femur
- Innervation: superior gluteal nerve (L4, L5, S1)
- Function: hip abduction, hip internal rotation

Gluteus Minimus

- Origin: gluteal surface of the ilium
- Insertion: greater trochanter of the femur
- Innervation: superior gluteal nerve (L4, L5, S1)
- Function: hip abduction, hip internal rotation, synergist to glute med
- Can commonly blend fibers with deep hip rotators (piriformis, superior gemelli, vastus lateralis)

Structure and function [1, 5, 17, 20, 21]

Gluteus Maximus

- The gluteus maximus is the largest muscle of the hip and the most superficial of the gluteal complex. Its principal function is performing hip extension and hip external rotation. Upper fibers can abduct the hip, while lower fibers can adduct

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the hip. When the distal attachment of the muscle is fixed it assists with trunk extension.

- Synergistically the glute max works with the semitendinosus and semimembranosus (hamstring) muscles during hip extension. It can also assist in knee flexion due to its attachment to the IT tract.
- Proper glute max strength contributes to core stability, correct postural alignment, functional mobility tasks, and knee alignment.
- Due to the anatomical attachments and line of force, the glute max is active during activities such as rising from sitting, straightening from a bent position, stair climbing, and running, while it is not very active during normal walking.

Gluteus Medius

- The gluteus medius is a fan-shaped muscle that lies underneath the gluteus maximus. Approximately 2/3 of the muscle is covered by glute max and aponeurosis, while 1/3 is exposed.
- At the hip joint, the glute med is the prime mover of hip abduction. It also contributes to hip flexion and internal rotation. It provides pelvic stability during single-leg stance, particularly during gait.
- When the proximal attachment of the glute med is fixed, if the muscle contracts as a whole it will cause hip abduction, whereas if only the anterior fibers fire, it will cause hip internal rotation.
- Throughout the gait cycle, the glute med serves to provide frontal plane pelvic stability, providing contralateral support of the pelvis during single-leg stance.
- Specifically, during gait the distal attachment of the muscle belly pulls the ilium inferiorly, allowing for slight ipsilateral pelvic tilt and raising of the pelvis needed to clear the opposite limb to take a step.
- Synergistically the glute med works with gluteus minimus and tensor fascia lata to facilitate hip internal rotation.

Gluteus Minimus

- The gluteus minimus is the deepest and smallest muscle in the gluteal complex.

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- It mainly acts as a synergist to the gluteus medius, assisting in hip abduction and internal rotation and acting as a hip stabilizer.
- The anterior portion of the muscle is synergistic to the tensor fascia lata facilitating internal rotation, while the posterior portion is synergistic to the piriformis. There is some thought that this portion of the gluteus minimus can contribute to hip external rotation.
- It plays a supportive role during the gait cycle, assisting to prevent pelvic drop.

Section 1: Key Concepts

- The gluteal muscle complex is composed of the gluteus maximus, gluteus medius and gluteus minimus.
- Glute max is the largest muscle of the hip complex and is a powerful hip extensor and external rotator. It is most active during powerful movements such as standing from a seated position, or climbing stairs. It is not very active in walking or standing.
- Glute med is the prime hip abductor and is responsible for single limb control during the gait cycle. It is also a hip internal rotator.
- Glute min is a synergist to the glute med and is the smallest and deepest of the gluteal complex. It is primarily a hip abductor and internal rotator, providing pelvic stability during gait.

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Section 1: Key Terms

Gluteus maximus - largest muscle of the hip joint, a powerful hip extensor, and external rotator. Most active during rapid force movements and quiet during walking and standing.

Gluteus medius - fan-shaped muscle responsible for hip abduction and internal rotation, controls the pelvis during gait, and provides stability in single-leg stance.

Gluteus minimus - synergist to the gluteus medius, smallest and deepest muscle of the complex.

Reflection Questions

1. Name the origin and insertion for the three muscles of the gluteal complex. How does origin and insertion impact muscle function for these three muscles?
2. What are the main actions of each portion of the gluteal complex? During which activity is each portion of the muscle group most active? Can you name two activities per muscle?

Section 2: Examination, tests, and measures

In order to recognize and treat impairments, it is important to understand the most common diagnoses related to the gluteal complex, while also demonstrating confidence and competency with proper testing and differential diagnosis. This section will cover key components needed on a physical therapist's examination, including observation, muscle testing, range of motion testing, gait analysis, and special tests to rule in/out different diagnoses specific to gluteal pathology.

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Observation [5, 10, 20, 21]

After listening to a patient's subjective description of their condition, observation of posture, gait, and joint alignment is an excellent place to begin an assessment. Looking at pelvic alignment, knee alignment, and foot alignment can provide clues to the rest of the examination.

- **Lower crossed syndrome** is a pattern of muscle imbalances that can lead to a misaligned pelvis and hip joint. It is characterized by the following:
    - Tightness of the hips flexors (iliopsoas and rectus femoris) coupled with tightness of the thoracolumbar extensors.
    - Weakness of the deep abdominals coupled with weakness of the glute max and glute med.
    - Typically, the hamstrings will compensate for an exaggerated anterior pelvic tilt or inhibited gluteal muscles.
    - Frequently lower crossed syndrome is also associated with hyper-lordosis of the lumbar spine and external rotation at the hip joint, along with flexed hips and knees.

- Movement assessment
    - Observe functional movements such as a squat, step-up/down, sit-to-stand, and single leg squat to get a picture of gross movement pattern abnormalities and their relationship across the hip, knee, and ankle joints.

Range of Motion [20, 21]

During active movements and range of motion testing, it is important to watch for force-couple imbalances associated with abnormal muscle recruitment.

- Normal active movements of the hip:
    - Flexion: 110-120 degrees (tested supine)
    - Extension: 10-15 degrees (tested prone)
    - Abduction: 30-50 degrees (tested side-lying)
    - Adduction: 30 degrees (tested side-lying)
    - External rotation: 40-60 degrees (tested in seated or prone)
    - Internal rotation: 30-40 degrees (tested in seated or prone)
- Differentiate between true hip extension and lumbar extension by observation the pelvis during ROM testing – for example, elevation of the pelvis from the mat is an indication of compensatory lumbar extension.
- During abduction watch for external rotation and flexion at the start of the range, as this is an indication of an overactive tensor fascia lata and a weak glute med/ glute min. If external rotation occurs later in the range, it can be indicative of an overactive psoas or piriformis.

A **capsular pattern** is a specific pattern of restriction in passive joint motion. When identifying the true cause of hip pain, it is important to determine if the root cause is an intra-articular problem or an extra-articular problem.

- Examples of intra-articular (within the joint itself) pain causes include a traumatic injury such as fracture, joint impingement, hyper/hypomobility of the joint, and pediatric conditions related to the development of the musculoskeletal system.

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- Examples of extra-articular (involving the surrounding tissues of the joint) include muscle strains, tendinopathies, and bursitis.
- Hip capsular pattern: loss of flexion > abduction > internal rotation
    - Closed pack position of the hip (resting position of maximum joint stability): full extension + internal rotation.
    - Open pack position of the hip (position of instability): 30 degrees of hip flexion, abduction + external rotation.

Muscle Testing [1, 5, 17, 20]

Muscle testing is important to identify and correctly guide the therapist's intervention and exercise selection for treatment. Options for muscle testing include manual muscle testing, isometric testing, or isokinetic assessment. A handheld dynamometer can also be utilized. Manual muscle testing is the most accessible to the practicing therapist. While looking at overall strength it is also important to watch for neuromuscular control of the contraction itself.

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Gluteus Maximus

- Patient position: prone, with the knee flexed to 90 degrees to isolate the glute max (minimize the contribution from the hamstrings).
    - Gravity eliminated is tested in side-lying.
- Test: the patient extends the hip through available ROM while the therapist applies resistance directly downward towards the floor.

Gluteus Medius

- Patient position: side-lying with testing leg lifted and slightly extended behind midline.
    - Gravity eliminated is tested in supine.
- Test: the patient resists the therapist's force without flexing or rotating the hip forward or backward.

Gluteus Minimus

- It is not possible to differentiate between the glute med and glute min during manual muscle testing.

Special Tests [14, 20]

Special tests can aid in ruling in and ruling out gluteal related pathologies.

Trendelenberg Sign

- This test assesses the ability of the hip abductors to stabilize the pelvis on the femur, in essence, an assessment of contralateral pelvic drop.
- In single leg stance, the opposite side of the pelvis should rise. If it drops, this is a positive test and indicative of weak hip abductors on the standing limb.

Hip Lag Sign

- This test assesses for the presence of gluteal tendinopathy. In side-lying, the therapist takes the hip into end-range hip abduction, extension, and external rotation.
    - A positive test is a drop > 10 cm.

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External De-rotation Test

- This test assesses for the presence of gluteal tendinopathy. In supine, the patient resists internal rotation from a position of hip flexion coupled with external rotation.
    - A positive test is the reproduction of lateral hip pain.

Thomas Test

- A flexibility test used to assess the extensibility of one and two joint hip flexors. In supine, the patient maximally flexes the contralateral hip while allowing the involved limb to drop into extension.
    - Important to assess as short hip flexors typically lead to less gluteal activation.

Ober's Test

- A flexibility test used to assess tensor fascia lata and iliotibial tract extensibility. In side-lying, the patient's hip is placed into extension and allowed to adduct the testing limb. The tested limb should drop to table height (or around 15 degrees).
    - Important to rule in or rule out ITB/TFL involvement due to their location on the lateral aspect of the hip.
    - Can be useful to determine trochanteric bursitis.

Gait Analysis [22]

Observational gait analysis is useful in identifying structural limitations, activity restrictions, as well as guiding treatment. For the purpose of this course, the following information follows the Rancho Los Amigos gait analysis system.

- In normal gait, the hip requires a maximum of 25 degrees of hip flexion and a maximum of 20 degrees of apparent hyperextension.
    - Apparent hyperextension refers to the combination of hip extension, backward pelvic rotation, and anterior pelvic tilt.

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Phases of gait: normal hip joint motion and muscle actions

- Initial contact
    - Hip ROM: 20 degrees of hip flexion
    - Extensor moment
        - Hip extensors and hip abductors are active to stabilize the pelvis on the femur.
        - Primary muscles stabilizing the thigh are the gluteus maximus and adductor longus.
- Loading response
    - Hip ROM: 20 degrees of hip flexion
    - Extensor moment

        - Glute max, adductor magnus, and hamstrings contract to counteract increasing flexion torque.
        - Glute med, glute min, and upper fibers of glute max peak in muscle activity during loading response as they provide frontal plane pelvic stability.
- Mid stance
    - Hip ROM: Neutral
    - Extensor moment transfers to flexor moment; however low hip abductors continue to be active to stabilize the pelvis.
- Terminal stance
    - Hip ROM: 20 degrees of apparent hyperextension
    - Increasing flexor moment, however, a hip extension torque maintains a stable hip joint.
- Pre-swing
    - Hip ROM: 10 degrees of apparent hyperextension
- Initial swing
    - Hip ROM: 15 degrees of flexion
    - Flexor moment
        - Hip flexors advance the thigh forwards.
- Mid swing
    - Hip ROM: 25 degrees of flexion
    - Extensor moment
        - Hamstrings initiate activity in late mid-swing.
- Terminal swing
    - Hip ROM: 20 degrees of flexion
    - Extensor moment

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- Hamstrings control thigh position and decelerate the leg, hip extensors and abductors becoming more active to prepare for initial contact.

Section 2: Key Concepts

- A physical therapist's examination should consist of key components that lead the examiner to a differential diagnosis that will guide treatment. This includes a thorough observation of posture and alignment, range of motion assessment, muscle strength testing, and gait analysis.
- It is important to identify if the pain and dysfunction are occurring due to an intra-articular problem or an extra-articular problem. Identification of capsular pattern of motion loss is helpful to help differentiate.
- To ensure accurate muscle testing the glute max should be tested with the testing limb bent to 90 degrees to reduce activity from the hamstrings.
- Special tests can help to rule in and rule out pathologies related to the gluteal complex. The Trendelenburg sign, hip lag sign, and external de-rotation test are all useful special tests to utilize during examination.
- During gait analysis, the glutes peak muscle activity occurs during loading response to manage frontal plane stability of the pelvis.

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Section 2: Key Terms

Lower crossed syndrome - a pattern of muscle imbalances characterized by tight hip flexors and thoracolumbar extensors coupled with weakness of abdominals and glute max and glute med.

Intra-articular - referring to within the joint itself – causes of hip pain include traumatic injury, impingement, hyper/hypomobility, and pediatric development disorders.

Extra-articular - referring to tissues outside the joint – causes of hip pain include muscle strains, tendinopathies, and bursitis.

Trendelenberg sign - an assessment of contralateral pelvic drop that indicates a weak gluteus medius on the supporting limb.

Hip lag sign - a special test used to rule in and rule out gluteal tendinopathy. In side-lying, the therapist takes the hip into end-range hip abduction, extension, and external rotation, a positive test is a drop > 10 cm.

Thomas test - a flexibility test of the hip flexors; important to assess due to the relationship between tight hip flexors and weak gluteal muscles.

Apparent hyperextension - the combination of hip extension, backward pelvic rotation, and anterior pelvic tilt needed to achieve full ROM needed for normal gait.

Reflection Questions

1. What are the key features of lower crossed syndrome? What postural compensations are typical of someone who presents with lower crossed syndrome?
2. When are the hip extensors most active during gait? The least active? What is the typical ROM needed for full normal gait mechanics? How would gluteal weakness affect the gait cycle?
3. Which special tests are useful in identifying gluteal tendinopathy? Can you describe the setup of each test?
4. How does the Thomas test relate to gluteal impairments? Can you incorporate an understanding of lower crossed syndrome into your analysis?

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Section 3: Common impairments and compensations

The glutes are the largest and most powerful muscle of the body, therefore it is not surprising that weakness and dysfunction in the gluteal complex cause an array of impairments. Properly functioning and strong glutes are important for a range of activities from our normal daily mobility to high-level athletic performance. This section will cover common impairments related to the gluteal complex, along with compensations commonly observed due to these impairments.

Dysfunction [10]

Why do the glutes become dysfunctional?

- Due to the typical American lifestyle, the majority of the population in the United States is very sedentary. Unfortunately, prolonged sitting has been shown to

reduce activation of the glute max. A sedentary lifestyle also predisposes the individual to lower crossed syndrome, poor posture, poor pelvic alignment, and muscle imbalances.

- **Reciprocal inhibition** refers to the relaxation of muscle on one side of the body to accommodate contraction on the opposite side of the joint. This relaxation can occur at the glutes in response to over-activity of the hip flexors, leading to **synergistic dominance** of the hamstrings and hip adductors to produce hip extension torque to compensate for weak and inactive glutes.
- Pain, inflammation, and swelling can all lead to muscle inhibition, resulting in modified movement patterns and imbalances.
- Pelvic alignment, mobility, and stability of the core musculature relate to gluteal function.
- Oftentimes low back pain can be related to gluteal dysfunction, along with impairments at the knee and ankle.

Lateral hip pain [14, 18, 19, 20]

Greater trochanteric pain syndrome (GTPS): Commonly known simply as lateral hip pain, GTPS is a common diagnosis that is frequently encountered by physical therapists. GTPS is an umbrella term that can have multiple causes and be related to multiple tissues. The most common causes of GTPS include gluteal tendinopathies, trochanteric bursitis, and ITB friction. It is almost always accompanied by gluteus medius muscle dysfunction. GTPS is usually described as persistent intermittent peritrochanteric pain accompanied by tenderness to palpation on the lateral aspect of the hip.

- Gluteal tendinopathy
    - Tendinopathy, or tendinosis, is defined as a decrease in collagen production of a tendon typically due to overuse. Without proper intervention, tendinopathy can lead to partial or full-thickness tears.
    - Gluteal tendinopathy is commonly described as an aching pain in the lateral hip with distinct tenderness around the greater trochanter. It is also associated with the Trendelenberg sign, pain with single-leg stance, pain with stair climbing, and pain sleeping on the affected side.

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    - Two special tests can be used during examination: the external de-rotation test and the hip lag sign.
    - Due to the lack of inflammation, steroid injections do not tend to provide pain relief.
- Trochanteric bursitis
    - Bursitis is defined as inflammation of the bursa (a fluid-filled sac between bony prominences), caused by repetitive friction. Multiple bursae can be the point of origin for pain, with the gluteus maximus bursa being the most commonly involved.
    - Similarly, to gluteal tendinopathy, it is frequently described as an aching pain in the lateral hip with distinct tenderness around the greater trochanter. It can also be associated with pain at end-range hip ROM, pain on resisted hip abduction, a positive Ober's test, or pseudo-radiculopathy (pain extending down the lateral thigh only).
    - Due to the relatively common presentation, it is often difficult to determine whether lateral hip pain is due to bursitis or another cause.
    - Frequently activity modification, therapeutic exercise and steroid injections all have a positive treatment effect for trochanteric bursitis.
- Snapping hip syndrome
    - Snapping hip syndrome occurs when a tissue rolls over a bony prominence of the hip. Most commonly lateral hip pain is associated with the ITB crossing the greater trochanter. The sensation can be accompanied by pain, or be pain-free.
    - It is typically due to overuse of the hip muscles and is usually managed conservatively with rest, activity modification, therapeutic exercise, stability training, and stretching.

Posterior hip pain [20]

While not specifically related to the glutes, due to the region of pain and symptom presentation it is important to address this condition in order to properly guide treatment and provide accurate differential diagnosis during examination.

- Piriformis syndrome
    - Piriformis syndrome is a condition where the piriformis muscle spasms, causing a deep aching in the buttock. This muscle spasm can also irritate the sciatic nerve, causing referred pain down the posterior thigh, stopping above the knee.
    - It is characterized by limited and painful passive hip internal rotation and painful resisted hip external rotation and is aggravated by sitting, squatting, and walking.
    - Common to be associated with sacroiliac joint dysfunction.

Gait deviations [7, 16, 22]

Due to the important role the glutes have in providing pelvic stability and powering hip extension during swing, there is a range of gait deviations related to impaired gluteal function.

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- Posterior pelvic tilt
    - Likely to occur during single limb stance to decrease the demand on the hip extensors.
- Posterior trunk lean
    - Likely to occur during weight acceptance to reduce the extensor moment during loading response.
- Lateral trunk lean
    - In response to weak hip abductors, can occur during both weight acceptance and swing limb advancement.
- Lack of forward pelvic rotation
    - Likely to occur during swing limb advancement as a compensatory response to reduce demand on quads and hip extensors at upcoming loading response.
- Ipsilateral pelvic drop

        - Likely to occur during swing limb advancement of the reference limb due to weak hip abductors on the opposite limb
        - Can lead to a lateral trunk lean to reduce abductor demands.
- Contralateral pelvic drop
        - Likely to occur during weight acceptance of the reference limb due to weak hip abductors.
        - Can lead to a lateral trunk lean to reduce abductor demands.
- Limited hip flexion
        - Likely to occur during weight acceptance to decrease demand on the hip extensors.

Gluteal weakness related to function and athletic performance [10, 11, 16]

Weakness or inhibition of the gluteal complex can lead to knee pain, back pain, and decreased athletic performance.

- Knee valgus (medial knee collapse)
        - Proper alignment of the pelvis and hip joint is important in proper knee alignment. Due to the ability of the gluteus maximus to extend, abduct, and externally rotate the hip, it is the main muscle related in preventing and counteracting medial knee collapse – which is a combination of hip adduction, internal rotation, and flexion.
        - If the gluteus maximus is weak or inhibited the hip will compensate by moving into excess hip adduction and internal rotation, exerting a valgus stress on the knee in order to maintain support of the femur under the pelvis.
                - This position of hip adduction and internal rotation is due to the synergistic dominance of the hamstrings and adductor magnus to achieve proper hip extension.
                        - Remember that the hamstrings and adductor magnus, while both being hip extensors, are also hip adductors.

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        - Poor neuromuscular control and poor recruitment of the gluteus maximus is oftentimes the culprit of excess knee valgus – the muscle itself can have adequate strength, but the ability to properly recruit and fire correctly can be impaired, resulting in medial knee collapse.
    - The position of increased valgus stress to the knee puts the knee at higher risk for ACL injury, patellofemoral pain syndrome, and ITB syndrome.
    - Medial knee collapse can occur during squatting, running, cutting, jumping, and single limb activities such as step-downs.
    - In high-level athletics where explosive movements and landing mechanics are frequently performed, it can be helpful to undergo a functional performance assessment to identify compensatory movement patterns.
    - Proper gluteal strengthening, neuromuscular re-education, and focus on proper positioning and form are important for treatment and intervention.
- Quadriceps dominance
    - When the glutes are weak or inhibited the hip flexors become dominant – this is related to lower crossed syndrome and a high incidence of increased back and knee pain, such as patellofemoral pain syndrome.
    - It is common to be quad dominant during activities such as squatting and running. A sedentary lifestyle, poor proprioceptive control of the glutes, and footwear that favors quad firing during exercise are all related to an increased incidence of quad dominance.
    - Consistent running on a treadmill can lead to quad-dominant running, due to the mechanism of the tread belt pulling the hip back into extension – leading to poor firing of the hip extensors. Quad dominant running can also lead to over-striding and decreased running speed.
    - The muscle fiber make-up of the quads is fast-twitch (easily fatigable) dominant, while the glutes are slow-twitch (endurance) dominant. As the quads fatigue and the glutes are not firing properly, it is difficult to maintain speed and power.

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- Addressing pelvic position, hip flexor tightness, proper neuromuscular control of the glutes and strength are all important factors in modifying quadriceps dominance.

Section 3: Key Concepts

- Dysfunctional glutes are a common occurrence amongst the largely sedentary American population. Prolonged sitting leads to tight hip flexors, weak glutes, and impaired neuromuscular control.
- Lateral hip pain (GTPS) is typically due to tendinopathy, bursitis, or ITB friction, along with gluteus medius dysfunction. It is described as lateral hip pain in combination with tenderness to palpation.
- Due to the role of providing pelvic stability during gait, there are multiple gait deviations related to weak glutes. The most common include contralateral pelvic drop, lateral trunk lean, and a rotated pelvis.
- Weakness or inhibition of the glutes can lead to issues at the back, knee, and ankle, including a propensity for excess knee valgus and quad dominance during athletic activity.

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Section 3: Key Terms

Reciprocal inhibition - relaxation of a muscle on one side of the body to accommodate contraction on the opposite side of the joint. For example, relaxation occurs at the glutes in response to over-activity of the hip flexors.

Synergistic dominance - in response to a weak or inhibited prime mover there is an increase in synergistic muscle activity. For example, the hamstrings and hip adductors compensate for weak and inactive glutes.

Greater trochanteric pain syndrome - an umbrella term to describe the multiple causes of lateral hip pain. It is caused by gluteal tendinopathies, trochanteric bursitis, and ITB friction. It is characterized by lateral hip pain accompanied by tenderness to palpation.

Gluteal tendinopathy - a cause of GTPS attributed to a decrease in collagen production of the gluteal tendon typically due to overuse. Along with lateral hip pain, it is most commonly associated with pain during single-leg stance and a positive Trendelenberg sign.

Trochanteric bursitis - a cause of GTPS attributed to inflammation of the hip bursa causing pain and tenderness. Difficult to differentiate between bursitis and tendinopathy. Will respond to steroid injections due to the presence of inflammation.

Snapping hip syndrome - a cause of GTPS that occurs when a tissue rolls over a bony prominence of the hip. Most commonly caused by the ITB crossing the greater trochanter.

Piriformis syndrome - a cause of posterior hip pain due to piriformis muscle spasms. Typically presents as a deep aching in the buttock. Can also irritate the sciatic nerve, causing referred pain down the posterior thigh.

Contralateral pelvic drop - a gait deviation caused by gluteus medius weakness resulting in a pelvic drop on the opposite side of the reference limb during weight acceptance.

Knee valgus - a medial force on the knee. This is often caused by a weak or inhibited gluteus maximus resulting in excess hip adduction and internal rotation.

Reflection Questions

1. Name four factors related to gluteal dysfunction.
2. What are the main causes of GTPS? In what ways can you differentiate between them?
3. What are the most common gait deviations related to gluteal dysfunction? At what phase of gait do they occur? What compensations would you expect to see?
4. Why does knee valgus occur as a result of a weak glute max? Which muscles become synergistically dominant?

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Section 4: Interventions and exercise selection

Physical therapists and physical therapist assistants should be well versed in different strategies to treat muscle weakness, impaired neural control, and restoration of proper joint mobility. Strengthening, neuromuscular re-education, stretching, and task-specific training all play a role in the treatment of gluteal impairments. This section will cover strategies to guide the progression of treatment, interventions, and exercise selection related to the glutes.

Correction of gluteal dysfunction and weakness [6, 10]

The following framework serves as a starting point when determining treatment interventions. Based on thorough examination and movement analysis, it is up to the clinical judgment of the therapist to determine which areas deserve the most attention and focus.

- Restoration of lumbopelvic stability
    - As touched on throughout this course, impaired pelvic positioning is closely related to gluteal dysfunction. Addressing and correcting an anterior pelvic tilt is a starting point to address both inhibited glutes, tight hip flexors, and weak core musculature.
    - Manual therapy, flexibility techniques, and self-massage can be used to restore proper ROM of tight hip flexors.
    - Focus on proper activation of the deep abdominal muscles to provide pelvic stability.
    - Treatments may include: hip flexor stretching, foam rolling, transversus abdominus draw-ins, and postural education.
- Addressing glute strength
    - Incorporating both functional weight-bearing (WB) movements, such as squats, lunges and deadlifts are important, alongside non-weight bearing (NWB) exercises such as clamshells, side-lying hip abduction, or prone hip extension, for further isolation or rehabilitation purposes.
    - Typically beginning with NWB exercises to develop adequate strength and proper firing of the glutes and progressing to more functional movement patterns and exercises is a good treatment strategy.
    - Correct form, progressive overload, and exercise variation are important considerations when creating an exercise program.
- Development of neuromuscular control
    - Coordination of movements, development of power, and translation of strength into functional and athletic performance is the last piece of the framework.

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- Moving beyond corrective exercise and building in a strategy of retraining functional movement patterns is crucial for increased strength gains to lead to improved function.
- For example, use of a mirror can provide visual feedback during a step down focusing on coordination of knee control and minimizing excess knee valgus.
- Adding in gait training and running training focusing on avoiding compensations, proper form (hip, knee, ankle alignment), and glute activation during stride and landing.
- Sport-specific tasks should be addressed on an individual and sport-specific basis.

Exercise selection [2, 3, 4, 6, 8, 9, 11, 12, 13, 15, 16]

Before selecting an exercise, the goal of the exercise needs to be considered. Choosing a purpose for the intervention - whether it be for muscle hypertrophy, correcting muscle recruitment, improvement of athletic performance - will help guide treatment. Corrective rehabilitative exercises (typically NWB) progress to focused strength training that builds to integrating functional movement patterns and performance.

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Exercise based on position:

The position of the exercise will vary for each patient dependent on goals and examination. Prone, quadruped, and side-lying exercises are an excellent place to start as most can be performed as NWB. Bridging (especially single leg) is one of the best exercises to recruit glute max strength when performed at the correct knee angle. As the goal of the exercise evolves and more functional and athletic purposes are sought, moving to weight-bearing activities and sport-specific tasks is important. The following list provides a starting point for exercise selection based on patient position.

- Prone/quadruped
    - Prone hip extension
    - Bird dog
    - Fire hydrant
- Bridging

        - Hip thrust
        - Double leg
        - Single leg bridge
        - To target the glutes bridges should be performed at ~135 degrees of knee flexion to reduce the hamstring synergy to hip extension.
- Abduction
    - Side-lying hip abduction
        - Adding internal rotation increases glute med activation.
    - Clamshells
    - Standing hip abduction
    - Banded walking
- Weight-bearing (functional)
    - Single leg squat
    - Single leg deadlift
    - Lunge
    - Step-ups
    - Step downs
    - Sit to stand
    - Wall sit
- Weight-bearing (athletic)
    - Lateral hopping
    - Forward hopping
    - Cutting
    - Split squat + cable around the knee

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Exercise based on muscle activation:

While exercises will overlap in their recruitment of the gluteal musculature, certain exercises lead to greater recruitment of the glute max versus glute med. The literature suggests that single limb exercises (such as a step up or a single leg bridge) lead to peak activation of the glute max and glute med. Hip abduction with added internal rotation leads to peak glute med activation. As previously stated, it is difficult to isolate the glute min which is a synergist for the glute med, so for the purposes of this section, it is included with glute med. Movement patterns such as lunges, squats, deadlifts, or planks will recruit all three gluteal muscles.

- Glute max
    - Single leg bridge
    - Step-ups
    - Lateral step up
    - Hip thrust
    - Single leg squat
    - Single leg deadlift
    - Wall sit
    - Bird dog
    - Prone hip extension
        - Evidence that adding a transversus draw-in yields greater glute max activation.
- Glute med/min
    - Side plank with hip abduction
    - Front plank with hip extension
    - Hip clams
    - Lateral banded walks
    - Side-lying hip abduction with IR

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- Single leg squat

Additional considerations:

- Bands
    - Adding a band around the knees can increase glute activation and is easy to incorporate into many exercises discussed in the above sections.
- Single limb exercise
    - Due to the role of the glute med in stabilizing the pelvis, single-limb exercises increase the firing of the glute med at higher rates than double limb exercise.
- Load
    - Consider the use of biomechanically advantageous movements (ex: bodyweight step-ups vs barbell squats).
    - Add weight or a band to increase the intensity once adequate strength has been built and proper form can be maintained with bodyweight.
    - Progressive overload refers to the principle of gradual increase in stress to build strength – through added weight, number of repetitions, or number of sets.
- Stretching
    - Hip flexors
        - Knee to chest stretch
        - ½ kneeling hip flexor stretch
        - Thomas position stretch
        - Lunge with spinal twist
    - Foam rolling
        - Targeting quads, hamstrings, glutes, and IT band.
- Core strengthening

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- Transversus activation
- Dead bug
- Planks (forearm, side)
- Bird dog

Section 4: Key Concepts

- Developing a treatment plan should incorporate a holistic approach addressing pelvic position, gluteal strengthening, neuromuscular control, and functional performance.
- Corrective exercise progresses to muscular strengthening and motor pattern re-integration followed by performance training.
- There are multiple positions to perform both NWB and WB gluteal strengthening exercises: prone/quadruped, bridging, side-lying, standing, and higher-level athletic activities.
- The glute max is activated most during step-ups, single-leg bridging, and hip thrusts.
- The glute med/min is most activated during hip abduction + internal rotation, clamshells, and lateral banded walking.

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Section 4: Key Terms

Lumbopelvic stability - referring to proper motor control and muscular strength of the lumbopelvic-hip complex.

Neuromuscular control - referring to the nervous system's ability to generate fast muscle firing, maintain dynamic joint stability and decrease joint forces while learning/ re-learning movement patterns and skills.

Progressive overload - the principle of gradual increase in stress to build strength – through added weight, number of repetitions, or number of sets.

Reflection Questions

1. Why is important to address pelvic positioning in relationship to impaired gluteal function? What are two interventions that may be used to address an anterior pelvic tilt?
2. When would non-weight-bearing exercises be used? For what purpose? Can you name 4 NWB exercises and describe the position they are performed in?
3. Which exercises lead to peak glute max activation? Peak glute med activation?
4. Incorporating knowledge of gluteus med structure and function, why does adding internal rotation to hip abduction exercises increase glute med activation?

Conclusion

The gluteal complex is one of the largest and strongest muscle groups in the body, key in ensuring proper posture, normal gait patterns, prevention of injury, athletic performance, and reduction of pain. Dysfunctional glutes can lead to an array of issues, related to the hip as well as in the joints above and below. Across all settings and patient populations, impaired gluteal function will be encountered. Physical therapists and physical therapist assistants need to be well versed in anatomical understanding of the glutes, proper examination techniques, knowledge of impairments, and treatment strategies to ensure evidence-based, patient-centered care.

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