Iliopsoas Muscle Injury in Dogs

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Abstract: The iliopsoas muscle is formed by the psoas major and iliacus muscles. Due to its length and diameter, the iliopsoas muscle is an important flexor and stabilizer of the hip joint and the vertebral column. Traumatic acute and chronic myopathies of the iliopsoas muscle are commonly diagnosed by digital palpation during the orthopedic examination. Clinical presentations range from gait abnormalities, lameness, and decreased hip joint extension to irreversible fibrotic contracture of the muscle. Rehabilitation of canine patients has to consider the inciting cause, the severity of pathology, and the presence of muscular imbalances.

Contrary to human literature, few veterinary articles have been published about traumatic iliopsoas muscle pathology.1-4 This is likely due to failure to diagnose the condition and the presence of concomitant orthopedic problems.5 In our experience, repetitive microtrauma of the iliopsoas muscle in association with other orthopedic or neurologic pathologies is the most common clinical presentation.

Understanding applied anatomy is critical in diagnosing muscular problems in canine patients (BOX 1 and BOX 2; FIGURE 1 and FIGURE 2).

Box 1. Anatomy of the Sublumbar Musculature

- The psoas minor muscle is the most ventral muscle arising from the ventral surfaces of the last thoracic and first four or five lumbar vertebrae and inserts on the ilium adjacent to the iliopubic eminence (FIGURE 1 and FIGURE 2).
- The psoas major muscle arises laterally from psoas minor muscle and ventral to the quadratus lumborum muscle from the last two thoracic vertebrae and ribs and most of the lumbar vertebrae and inserts, in common with the iliacus muscle as the iliopsoas, on the lesser trochanter of the femur.9
- The iliacus muscle arises from the ilium and fuses with the psoas major muscle to insert on the lesser trochanter of the femur.
- The iliopsoas muscle is innervated by the femoral nerve which is formed by the nerve roots L4, L5 and L6.9
- The quadratus lumborum muscle arises dorsal to the psoas muscles from the ventral surfaces of the 10th to 13th thoracic vertebrae to insert on the first three lumbar vertebrae as well as the ventral aspect of the sacrum and ilium.9

Box 2. Main Functions of the Iliopsoas Muscle

- Flexion of the hip joint
- Adduction and external rotation of the femur
- Core stabilization:
  — Flexion and stabilization of the lumbar spine when the hindlimb is fixed
  — Caudal traction on the trunk when the hindlimb is in extension

Pathophysiology of Muscular Injuries

Muscular injuries are usually classified as contusions (blunt trauma), strains (indirect injuries), vascular compromise, or lacerations (sharp injuries).5,6 Due to its profound and protected location, the iliopsoas muscle is more likely to be affected by strain injuries. Muscle strain injuries are common in humans and dogs and result from excessive stretch or stretch while the muscle is activated (i.e., eccentric contraction).5,8 When the muscle tears, the damage is usually localized close to the muscle-tendon junction or the origin of the tendon and less commonly in the muscle belly.5,7

In veterinary medicine, strain injuries are classified as follows8,9,10:

- Stage I (mild strain): myositis and bruising but architecture intact
- Stage II (moderate strain): myositis and some tearing of the fascial sheath
- Stage III (severe strain): tearing of the fascial sheath, muscle fiber disruption, and hematoma formation

Chronic muscular injuries include repetitive strain injuries and/or myofascial pain syndrome and contractures, which are not well described by this structural classification system. In our
experience, chronic repetitive microtrauma of the iliopsoas muscle is more common in dogs.

**Acute Muscular Strain Injuries**

Acute muscular strain injuries are caused by an explosive motion such as turning or twisting during a jump, fall or slip. Muscles are particularly vulnerable during an eccentric contraction, when the intramuscular forces are greatest and fewer muscle fibers are activated.\(^{3,11}\)

Typical anamnesis in conjunction with pain, swelling, loss of function, and hematoma formation can help to confirm the diagnosis of muscular injury.\(^{12}\)

However, owners often do not appreciate the occurrence of a traumatic event, resulting in an inaccurate history.

Sporting and working dogs may be particularly at risk for acute, traumatic muscle strains. Insufficient muscle conditioning, such as weak core stabilizers and imbalances between muscular agonists and antagonists, can increase the risk of a muscular stretch injury. Further predisposing factors include inflexibility of the affected muscles, inadequate warm-up, and, particularly, muscle fatigue.

The mildest form of strain injury includes the so-called delayed-onset muscle soreness (DOMS) after repeated powerful muscle contractions. The site of maximal damage appears to be the Z-band of the sarcomere, where thick filaments are anchored. The Z-band disruption causes muscle cell damage with calcium influx and initiates an inflammatory response. The muscle swelling causes soreness and stiffness.\(^{13}\) This stage may be difficult to recognize unless it affects a performance dog. With appropriate rest, complete recovery usually occurs within a few days.

More severe strain injuries (stages II and III) are characterized by rupture of muscle bundles. As long as the muscle fascia remains intact, bleeding remains intramuscular, but with a concurrent fascial tear, bleeding expands into the intermuscular space. The most severe injury is a complete muscle tear with total loss of function.

Following strain injury, scar tissue formation competes with and protects regeneration of muscle fibers. Resting satellite cells in the extracellular matrix are stimulated to proliferate and to differentiate into myoblasts, which then fuse to form multinucleated myotubuli.\(^{14}\) Although fibroplasia from scar tissue provides some stabilization of the wound, it also creates a barrier for the newly formed myofibrils.\(^{14,15}\)

**Chronic Muscular Strain Injuries**

More common, but also more subtle, are chronic muscular strain injuries. We see many dogs with lower back pain or hip or stifle pathologies that express a pronounced pain reaction upon direct palpation of the iliopsoas muscle ventral to the ilium or at its insertion point on the lesser trochanter. Protecting a painful joint by limiting its range of motion, the iliopsoas muscle fatigues, leading to local ischemia, acidosis, and swelling. The resulting exhaustion of ATP leads to a long-lasting muscle contracture. In people, it is hypothesized that during muscle fatigue, muscle spindle activity increases (excitatory signal) and Golgi tendon organ activity decreases (inhibitory signal), leading to increased muscle membrane excitability that can result in cramps.\(^{16}\)

Repetitive strain injuries and muscle fatigue can both initiate the same vicious cycle of inflammation and fibroplasia resulting in pain, muscle shortening, and adhesions. These chronic local muscle injuries are also called myofascial trigger points and can be palpated in more superficially located muscles as dense, hard, painful knots.\(^{17}\) If a muscle remains shortened over a longer period of time, distensibility is progressively lost, leading to irreversible muscle contracture. The formation of an insertion tendinopathy at the level of the lesser trochanter is also more frequently associated with repetitive strain injuries.

**Clinical Presentation**

The lameness or gait abnormalities associated with an iliopsoas muscle injury vary and can be acute or chronic, unilateral or bilateral.\(^{2,3,17–21}\) A reduction in hip extension resulting in a shortened stride is characteristic. An improvement with time is often observed, especially with acute stage I strains.\(^{5,6}\) Affected dogs can be any size or age and of either sex. Typically, iliopsoas myositis is distinctly painful, particularly if the femoral nerve becomes compressed inside the swollen or fibrosed muscle belly (FIGURE 3 and FIGURE 4).\(^{20–22}\) It is not uncommon that pain in the iliopsoas muscle secondary to another pathology exceeds that of the primary orthopedic problem. In certain cases, the pain originating from the iliopsoas muscle...
may persist due to insufficient rehabilitation, causing continuous strain on a weakened muscle even after resolution of the inciting cause.

Direct palpation of the iliopsoas muscle and its insertion point is highly sensitive in localizing the source of pain and is accentuated with the hip joint in extension and the femur internally rotated (BOX 3).

If hip joint pathology is the cause of pain during extension, simultaneous palpation of a normal iliopsoas muscle will not aggravate the animal’s response.

Other muscle groups can be affected simultaneously, including the pectineus, gracilis, and semitendinosus muscles. Iliopsoas myositis is often associated with other neurologic or orthopedic problems, which must be diagnosed and treated concurrently.

Decreased hip extension is commonly observed and is the result of pain-induced muscular spasm and shortening or fibrosis with advanced chronic lesions. A fibrotic iliopsoas muscle can be palpated as a distinct rigid band ventral to the ilium in the groin, preventing full extension of the hip joint.

A femoral neuropathy has also been described, caused by the close anatomic relation of the femoral nerve and the iliopsoas muscle (FIGURE 3; FIGURE 4). Clinical signs include decreases in patellar reflex and conscious proprioception, hindlimb weakness, and quadriceps femoris muscle atrophy. Rarely, loss of cutaneous nociception can be detected on the medial aspect of the hindlimb.

Transient increase in muscle enzyme activity is common with, but not specific for, an individual muscle group.

**Diagnostic Imaging**

Radiographic examination of the affected hindlimb allows visualization of lesser trochanter avulsion or dystrophic calcification at the insertion of the iliopsoas muscle as well as the diagnosis of other orthopedic problems (FIGURE 5). Dystrophic calcification does not necessarily mean active disease.

Ultrasonography is commonly used to examine traumatized muscles as it is widely available, cost-effective, and noninvasive. Repeated evaluations during the recovery period are easily performed. However, the results of the examination are highly operator dependent. Normal muscle tissue appears as homogeneous hypoechogenic parenchyma with multiple hyperechogenic regions or lines, according to the section chosen. Acute strains are characterized by muscle swelling and hypoechogenic zones caused by edema, inflammation, or hemorrhage, whereas chronic lesions are hyperechogenic from fibrosis or ectopic mineralization (FIGURE 6). Magnetic resonance imaging (MRI) is the best imaging modality for detecting musculotendinous lesions. During MRI, normal muscle tissue produces a homogeneous, hypointense signal in T1...
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Myositis generates a hyperintense signal in the T2 sequence, which is considered the best sequence to visualize muscular lesions.\(^{28,29}\) Intravenous injection of gadolinium as a contrast agent can amplify lesions during T1 sequence acquisition (Figure 7).

Although definitive diagnosis of muscle lesions would require histopathologic examination, orthopedic examination in conjunction with advanced imaging allows an accurate diagnosis most of the time, limiting the need for more invasive procedures.

**Treatment**

Muscle injuries follow three partially overlapping phases of healing (Box 4). The initial treatment is described by the acronym RICE (rest, ice, compression, elevation). Ice can be applied to the groin and T2 sequences (Figure 7).\(^ {28}\) Myositis generates a hyperintense signal in the T2 sequence, which is considered the best sequence to visualize muscular lesions.\(^ {28,29}\) Intravenous injection of gadolinium as a contrast agent can amplify lesions during T1 sequence acquisition (Figure 7).

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**Box 4. Healing Phases of Strained Skeletal Muscle\(^ {6,7,12}\)**

1. **Inflammatory phase:** rupture followed by necrosis, hematoma formation, and inflammation accompanied by muscular spasm and pain.

   Immobilization limits damage, gap and hematoma formation, and protects early granulation tissue. Application of ice is less effective with iliopsoas muscle strains due to the deep location of the muscle.

2. **Proliferating phase:** phagocytosis of the necrotic tissue, stimulation of satellite cells in the extracellular matrix to regenerate muscle cells in association with scar tissue formation, revascularization, and reinnervation. Between 5 and 10 days after trauma, physiologic tension improves vascular ingrowth, cell orientation, and regeneration of muscle fibers.

   Rehabilitation techniques used during this phase include progressive muscle stretching, joint mobilization, massage of surrounding musculature, low-dose laser therapy, shock waves, and therapeutic ultrasound. Toward the end of the proliferating phase, muscle strengthening and proprioceptive exercises are included, which should be adapted to the severity of the existing trauma.

3. **Remodeling phase:** maturation of the regenerated muscle cells, fibrosis, contraction and remodeling of the scar tissue, and functional recovery. The main objective during the remodeling phase is improving core stability and correcting existing muscular deficits.

Reported local effects of cryotherapy include vasoconstriction and reduction in edema formation, hemorrhage, histamine release, local metabolism, muscle spindle activity, nerve conduction velocity, pain, and spasticity.\(^ {30}\)

Due to the deeper location of the iliopsoas muscle, the effect of cold application diminishes rapidly between the skin level and underlying muscle.

Rest forms the cornerstone of all treatments, although the anatomic location of the iliopsoas muscle prevents complete immobilization. Immobilization following a muscle injury reduces intramuscular bleeding and scar volume and allows some maturation and stabilization of the granulation tissue. In human athletes, strict immobilization during the first 4 to 6 days is recommended.\(^ {12}\)

During the inflammatory phase, NSAIDs decrease inflammation and pain and are given usually for a period of 5 to 10 days.\(^ {5,31}\) Clinically, NSAIDs help to achieve faster normal muscle activity, but in two experimental animal studies, histologic healing was delayed.\(^ {32,33}\)

In chronic muscular strain injuries, the inflammatory reaction is not a main feature and, therefore, NSAIDs are less effective unless concurrent orthopedic problems exist. Methocarbamol, a centrally acting muscle relaxant, has been associated with better recovery in people, decreasing muscular spasticity and pain. In dogs, a dose of 40 to 60 mg/kg body weight three times per day on day 1, followed by 20 to 40 mg/kg three times per day for another 5 to 10 days has been recommended.\(^ {5}\)

In some patients, additional pain relief may be necessary and can be provided in the form of an oral or transcutaneous opioid.
Local treatment with platelet-enriched plasma (PEP) is under investigation in humans with promising results, although no standard protocol exists yet.\textsuperscript{14} PEP provides a high concentration of cytokines and growth factors locally, which can enhance recruitment of satellite cells and amplify the healing stimulus.\textsuperscript{34–36}

During the proliferating phase, vascular ingrowth, regeneration of muscle fibers, and cell orientation are improved when physiologic tension and load are applied (Box 4).\textsuperscript{12} Regeneration of muscle fibers starts early, between 3 and 5 days after injury, and peaks during the second week.\textsuperscript{7} The time for transition between immobilization and mobilization has to be individually determined, based on the severity and chronicity of the muscular lesion and clinical signs. In humans, it has been reported that mobilization should begin between 5 and 10 days after trauma to maximize vascularization and muscle fiber orientation.\textsuperscript{12}

Under ideal conditions, the tensile strength of the scar tissue reaches values similar to or greater than those of the surrounding muscle tissue 10 days after the trauma.\textsuperscript{12}

Manual therapy, including range-of-motion exercises, stretching, and massage, forms the mainstay of rehabilitation. These passive exercises must be adjusted to the individual patient to avoid acute pain and worsening of clinical signs.\textsuperscript{37,38} Involving owners in therapy by teaching them proper techniques provides continuous and intensive rehabilitation. Early mobilization is started with passive flexion and extension of the hip joint in combination with stretching of the iliopsoas muscle. Range-of-motion exercises can limit fibrosis and adhesions and enhance blood and lymphatic flow and are performed three to six times daily for 10 to 30 repetitions.\textsuperscript{37,38}

Stretching is one of the most important manipulations of physical therapy. Restoring normal muscle length and distensibility breaks the vicious cycle of spastic shortening and modulates alignment of the repair tissues. Keeping the hip joint in extension for 30 to 60 seconds at a time up to three times a day for two to five repetitions is a practical recommendation in dogs.\textsuperscript{37,38}

Massages (rubbing, kneading, friction, or tapping) are easy to employ and useful to break the self-perpetuating cycle of muscle spasm leading to muscle shortening, which is a source of pain.\textsuperscript{38} The physiologic properties stem from reflex and mechanical effects. A practical recommendation for localized massage is approximately 10 minutes per day.\textsuperscript{38}

Other physical modalities employed in muscle injuries include superficial heat from hot packs and deep heat from ultrasound. Heat increases collagen extensibility, blood flow, pain threshold, macrophage activity, nerve conduction velocity, and enzyme activity and decreases muscle spasm. Shock-wave therapy and low-dose laser applications may also be helpful in some individuals.\textsuperscript{39}

Conservative treatment requires a progressive plan adapted to the patient. During muscular conditioning, the development of general muscular strength and neuromuscular coordination precedes the work-specific adaptations. Improving core stability is the mainstay of any rehabilitation program.

Physical therapy is highly effective when initiated early. A study conducted on 25 dogs with iliopsoas injury demonstrated that dogs recovered completely with conservative treatment when lesions were present for <1 month.\textsuperscript{2} Shortening the recovery period, insufficient muscular conditioning, and neglecting the initiating cause of the injury pose a risk for reinjury and chronic muscular damage.\textsuperscript{5}

**Surgical Therapy**

Surgical treatment is rarely necessary in acute iliopsoas injuries.\textsuperscript{3,17,19} Indications include chronic or recurrent lesions unresponsive to conventional therapy and fibrotic contracture of the iliopsoas muscle.\textsuperscript{20–22} Tenotomy of the iliopsoas muscle tendon through a ventral or cranialateral approach provides rapid pain relief and restoration of range of motion in the hip joint.\textsuperscript{19–23} The attachment to the iliacus muscle preserves core stability to a large degree. The outcome (pain relief and range of motion) is good if surgery is combined with physical therapy and the initiating factors are controlled (Figure 8). However, some decrease in performance should be anticipated in athletic dogs.

**Conclusion**

Iliopsoas strain injuries are underdiagnosed in dogs. Primary traumatic lesions associated with an intensive sporting activity or accident seem to be less commonly presented to a veterinarian than secondary lesions associated with concomitant orthopedic problems such as hip dysplasia or cranial cruciate ligament rupture. Problems related to the iliopsoas muscle are readily diagnosed during a general orthopedic examination. Advanced imaging modalities help to confirm the diagnosis and detect associated pathologies.

Conservative treatment, including rest, medical treatment, physical therapy, and muscular reconditioning, is successful in most patients, particularly if no other orthopedic or neurologic problems are present. Surgical treatment can be considered in cases unresponsive to conservative treatment.

**References**


1. The most frequent cause of iliopsoas muscle injury is
   a. contusion.
   b. strain.
   c. vascular compromise.
   d. laceration.

2. Which muscles fuse to form the iliopsoas muscle?
   a. psoas minor and iliacus
   b. psoas major and iliacus
   c. psoas major and quadratus lumborum
   d. psoas minor and quadratus lumborum

3. The distal insertion point of the iliopsoas muscle is
   a. the lesser trochanter, on the proximomedial aspect of the femur.
   b. the lesser trochanter, on the caudal aspect of the femur.
   c. the ventral aspect of the ilium wing.
   d. the iliopubic eminence.

4. The main functions of the iliopsoas muscle include
   a. flexion of the hip joint.
   b. adduction and external rotation of the femur.
   c. flexion and stabilization of the lumbar spine when the hindlimb is fixed.
   d. all of the above

5. Femoral neuropathy has been reported in association with iliopsoas injury because
   a. the femoral nerve ends in the iliopsoas muscle.
   b. muscle injury causes stretching of the femoral nerve.
   c. the femoral nerve may become compressed inside the iliopsoas muscle.
   d. dystrophic muscle calcification causes neuritis.

6. Which statement is correct with regard to iliopsoas muscle strains?
   a. They are more commonly associated with other orthopedic or neurologic problems.
   b. They are always acute.
   c. They are classified into five stages.
   d. They are more common in old, sedentary dogs.

7. Which examination technique does not help localize an iliopsoas muscle injury?
   a. hip extension associated with internal rotation
   b. palpation of the distal insertion of the muscle on the lesser trochanter
   c. palpation of the muscle belly, ventral to the wing of ilium
   d. hip adduction

8. Which imaging modality is the most sensitive for diagnosing iliopsoas muscle strain?
   a. magnetic resonance imaging
   b. ultrasonography
   c. radiography
   d. thermography

9. Which statement is incorrect with regard to surgical treatment of iliopsoas muscle injury?
   a. Surgical treatment is indicated when chronic or recurrent lesions are unresponsive to conventional therapy.
   b. Surgical treatment is associated with a good outcome when combined with physical therapy.
   c. Surgical treatment refers to iliopsoas tenotomy.
   d. In athletic dogs, surgical treatment is always preferable to conservative treatment.

10. Which statement is true with regard to muscle injury?
    a. Muscle fibers can regenerate after an injury.
    b. Immobilization is mandatory during all phases of muscle healing.
    c. Satellite cells are precursors of myocytes.
    d. NSAIDS are less effective in acute muscle injuries.