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Subjective Gait Evaluation

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1.1 Introduction

Lameness can be due to orthopedic, oncologic, or neurologic conditions that disrupt the tissues responsible for normal locomotion. Subjective gait analysis is one component of the orthopedic and neurologic examination and provides valuable information to assist in determining what limb(s) and structures are affected. Succeeding chapters further discuss the other components that play an important role in any canine lameness evaluation (e.g. history, orthopedic examination, etc.).

1.2 Observation at Rest

Subjective gait evaluation starts by observing the animal at rest, when it stands, or raises from a sitting or lying position. Frequently, this can be accomplished by letting the animal roam freely in the exam room during the history taking. During this time, the observer may also evaluate mental status, behavior, and posture of the patient (which is part of the neurologic exam, see Chapter 4). Many dogs will show obvious off-loading of the affected limb during standing (Video 1.1), particularly with cranial cruciate ligament disease and neurogenic (i.e. nerve root signature) lameness. Caution should be used when interpreting off-loading if the animal is not standing square. Anxious animals may be encouraged to stand still by leading them toward an exit door, pausing prior to opening the door. Most dogs will focus on the door being opened and while being distracted, the observer can judge weight-bearing in a square position.

Video 1.1:

Pelvic limb lameness – unilateral CCLD.

Canine Lameness, First Edition. Edited by Felix Michael Duerr.

Companion website: www.wiley.com/go/duerr/lameness

Difficulty in either rising, or sitting, or both suggests a problem in the hind end. For example, animals with cranial cruciate ligament disease will display a classic sitting pattern avoiding flexion of the affected stifle(s). Animals that sit "square" (Chapters 19 and 20; Video 20.2) are unlikely to suffer from cruciate disease. Animals with lumbosacral disease may have difficulty rising, while animals with bilateral cruciate disease will hesitate to sit down. Spontaneous knuckling (i.e. standing on the dorsum of their paw during stance) indicates neurologic disease.

1.3 Observation in Motion

During the subjective gait evaluation, the observer is attempting to localize and specify the type of lameness (e.g. which leg is most severely affected, neurologic versus orthopedic origin, etc.). Certain gait features, such as ataxia or dragging/scuffing of the toes, clearly indicate neurologic disease. Decreased range of motion in a joint and the associated gait changes may point toward an articular source of the lameness. Changes in stride length may indicate a musculoskeletal or neurologic problem. Increased range of motion may indicate a ligament problem (such as carpal hyperextension injury with increased carpal extension or Achilles tendon rupture with increased tarsal flexion).

The use of slow-motion video analysis for improving the observer's ability to identify a lameness has been reported in dogs and horses; however, no clinical benefit was observed in a recent canine study using dogs (He Lane et al. 2015). Although in that study the degree of lameness was not quantified. Nonetheless, in the author's experience, this technique can be extremely helpful in dogs with a subtle lameness (Video 1.2). Slow-motion videography is integrated into newer smart phone devices and numerous apps also offer this feature, thus making it easily utilized in daily practice.

Video 1.2:

Thoracic limb lameness – case examples.

1.3.1 Presentation

Ideally, the animal is presented by a dedicated handler/technician. Since most owners are not used to walking their dog without interfering with gait, this approach will allow reducing the time required to complete the lameness evaluation: the handler should allow the animal to move freely (e.g. not pulling on the leash) yet at a constant speed. Pulling on the leash makes observation of a head nod more difficult. Ideally, the animal should look straight ahead during evaluation. This can be accomplished by letting the animal walk toward the owner.

The animal should be observed at the walk and ideally at the trot if the severity of the lameness allows. In general, if animals are unable to trot, their disease should be severe enough that lameness identification can be done at a stance or walk. A flat, even surface with good traction, such as a parking lot or driveway, is ideal to avoid distractions (such as areas to sniff/mark). The gait should be viewed both from the side (to judge stride length, symmetry, and possible changes in sagittal joint range of motion) and the animal moving toward and away from the examiner (to judge head nod, pelvic tilt, and frontal plane abnormalities).

To make a lameness more detectable, the animal can be asked to trot in circles, walk stairs, go up and down hills, or perform the tasks that trigger an impaired gait or movement (e.g. such as jumping for agility dogs). For example, animals with thoracic limb disease will display a more pronounced head nod when going downstairs and will use the non-affected limb to step down first. Animals with hip dysplasia will show simultaneous advancement of the pelvic limbs (i.e. "bunny hopping") when going upstairs. Subjective gait evaluation generally is performed prior to manipulation; however, sometimes manipulation may worsen the lameness.

1.3.2 Gait Patterns

To allow the clinician appropriate evaluation of gait, an understanding of normal gait patterns is essential. Gait patterns are generally described by their beat, whether they have a suspension phase and whether they are lateral or diagonal gait patterns. The *beat* describes the number of ground impacts within each stride cycle (i.e. the walk is a four-beat gait because each limb touches the ground at different time points within the stride cycle). The *suspension phase* describes a phase where none of the feet are touching the ground, which is observed only in gaits with a high velocity like the trot and canter. The description of *diagonal versus lateral* gait describes which limb pair is supporting the animal's weight (i.e. a diagonal gait indicates that the diagonal limb pairs move simultaneously such as when trotting; whereas, in a lateral gait, the ipsilateral limb pairs move simultaneously such as when pacing). For detailed online descriptions of the footfall patterns and slow-motion animations, consult Datt and Fletcher (2012).

The dog's ambulatory motion has been described to consist of up to seven different gait patterns: walk, trot, pace, amble, canter, transverse and rotary gallop (Leach et al. 1977; Datt and Fletcher 2012). The *walk* is a four-beat gait without a suspension phase. The *amble* is an accelerated walk, maintaining the four-beat gait pattern. The *trot* is a two-beat, diagonal gait with suspension phase. The *pace* is a two-beat, lateral gait in which ipsilateral limb pairs move in synchrony (Figure 1.1 and Video 1.3). The *canter* is an asymmetric gait (i.e. a three-beat gait with different patterns on the right and left side). The *gallop* is the fastest gait. While there has been controversy whether the pace is a normal or abnormal gait, it has been described to be used by dogs without obvious orthopedic disease. Proposed reasons for dogs to pace include orthopedic pathology, tiring, confirmation such as proportionally long legs, or an acquired gait due to being forced to walk at speeds between the walk and trot (Wendland et al. 2016). Particularly if a dog switches from a regular walk to pacing, evaluation for any change in orthopedic status is indicated. However, while pacing as the only symptom (i.e. without obvious lameness) may be an early indicator of musculoskeletal disease, it should not be considered pathologic by itself. Regardless, it is important for the clinician to assess whether a dog uses the pace.

Video 1.3:

Trotting versus pacing.

Another important reason to understand gait patterns is to allow for interpretation of compensation patterns for lameness such as head nod or pelvic tilt. The trot is the most steady and rhythmic gait and therefore generally the easiest gait to identify a mild–moderate lameness. Interpretation of lameness becomes more complicated in animals that are pacing. As such, if the animal can be

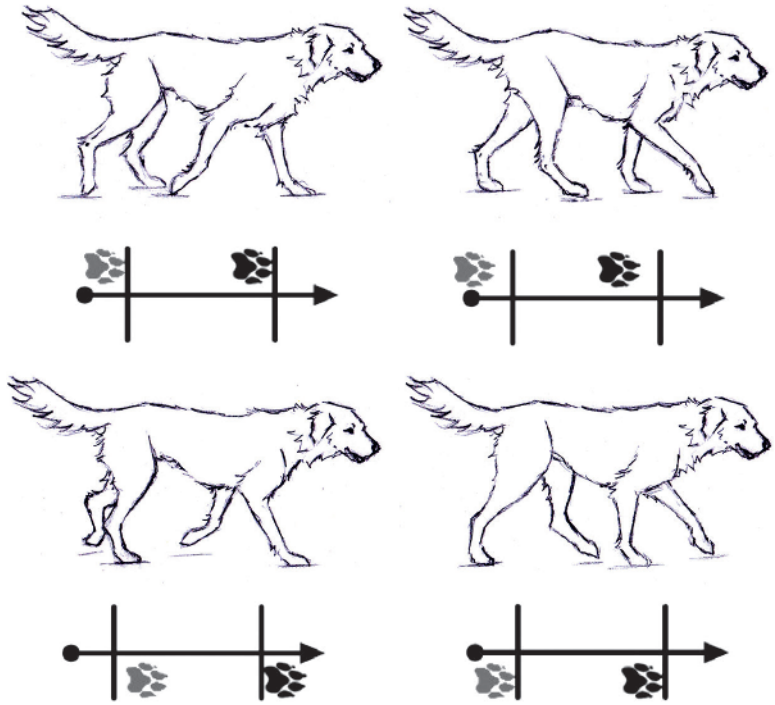

Figure 1.1 Simplification of the footfall patterns of the pace. The pace is a symmetrical lateral gait, meaning that ipsilateral limb pairs move simultaneously. Black paw prints represent thoracic limb feet and grey paw prints represent pelvic limb feet.

discouraged from pacing by choosing a different velocity (e.g. by having the handler increasing speed, see Video 1.3), this may simplify the subjective gait analysis.

1.3.3 Head Nod and Pelvic Tilt

To unload a painful limb, animals use specific adaptive strategies to reduce pain associated with weight-bearing. This is accomplished by shifting weight toward the unaffected limb(s), changes in joint angles, and alterations in foot flight. In horses, the most consistent compensatory movements are the vertical displacement and acceleration of the head in thoracic limb lameness and the vertical movement of the pelvis/tuber coxae in pelvic limb lameness (Baxter and Stashak 2011; Ross 2011). However, an overlap of these movements has been described (i.e. head movement with pelvic limb gait abnormalities particularly if lameness is severe).

Vertical head movement (i.e. the head and neck moving up and down during ambulation), also described as a head nod or head bob, is generally associated with thoracic limb lameness. It is observed because the animal attempts to off-weight the affected leg. The head is lowered when the non-affected thoracic limb touches the ground and raised when the affected thoracic limb touches the ground (Figure 1.2 and Video 1.2). To reduce the amount of weight placed on the affected limb, raising of the head happens just before the foot touches the ground. This can be observed in slow motion and in horses it has been suggested that raising of the head and neck may be easier to observe than the lowering (Ross 2011). A head nod may also be observed with severe pelvic limb lameness, because the animal is attempting to shift its body weight forward. Since the trot is a diagonal

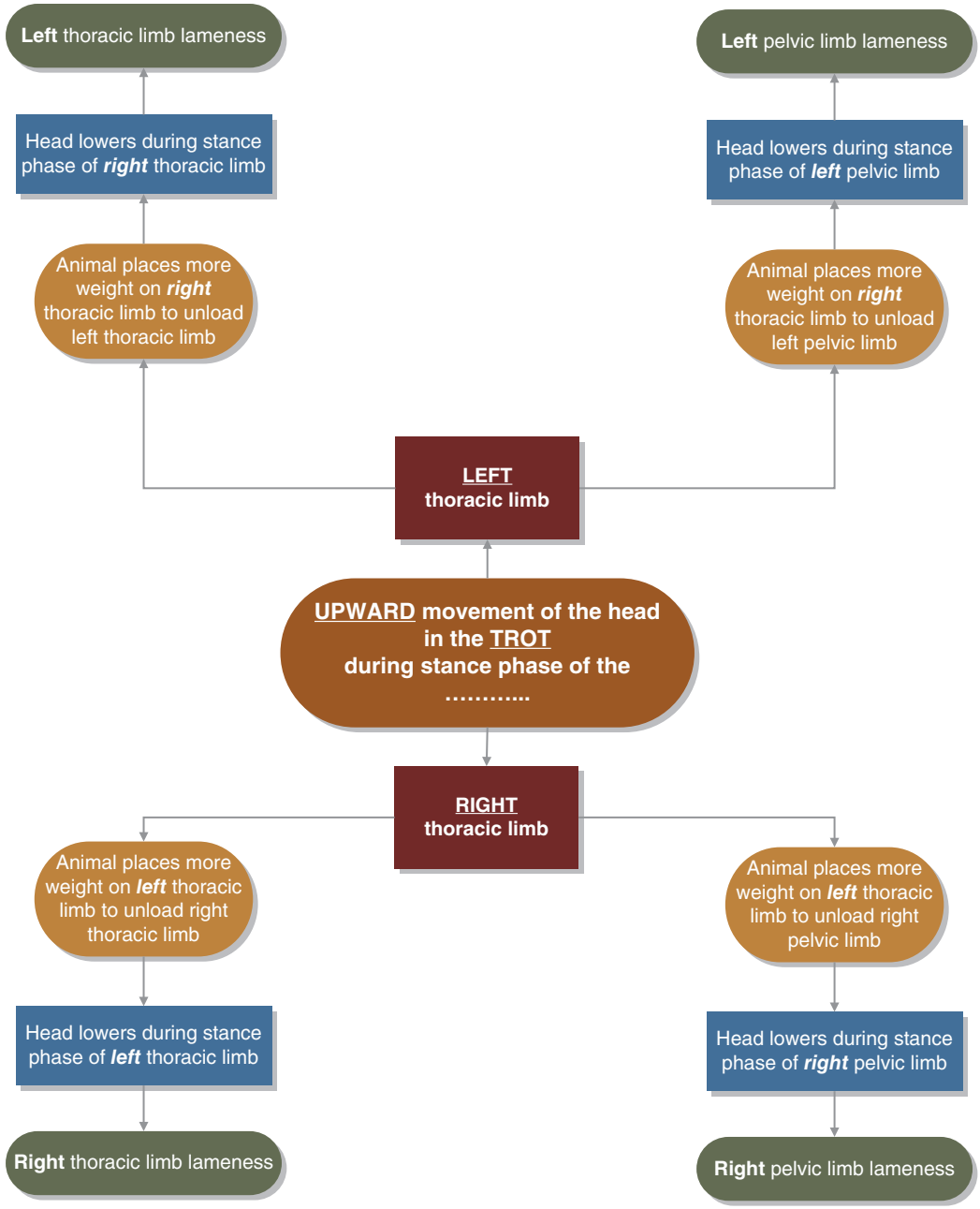

Figure 1.2 Interpretation of head movement for canine lameness during trotting (a diagonal gait), illustrating the interpretation of upward movement of the head and neck during stance phase.

gait, the head nod of a pelvic limb lameness will mimic a thoracic limb lameness of the ipsilateral side. For example, if the head is lowered during the left front stance phase, this indicates a right thoracic limb lameness or a right pelvic limb lameness (or both which would result in an exaggerated head nod). It is important to understand that these concepts only apply to a diagonal gait (i.e. the trot). When the animal paces, the opposite is true (i.e. a right thoracic limb lameness mimics a

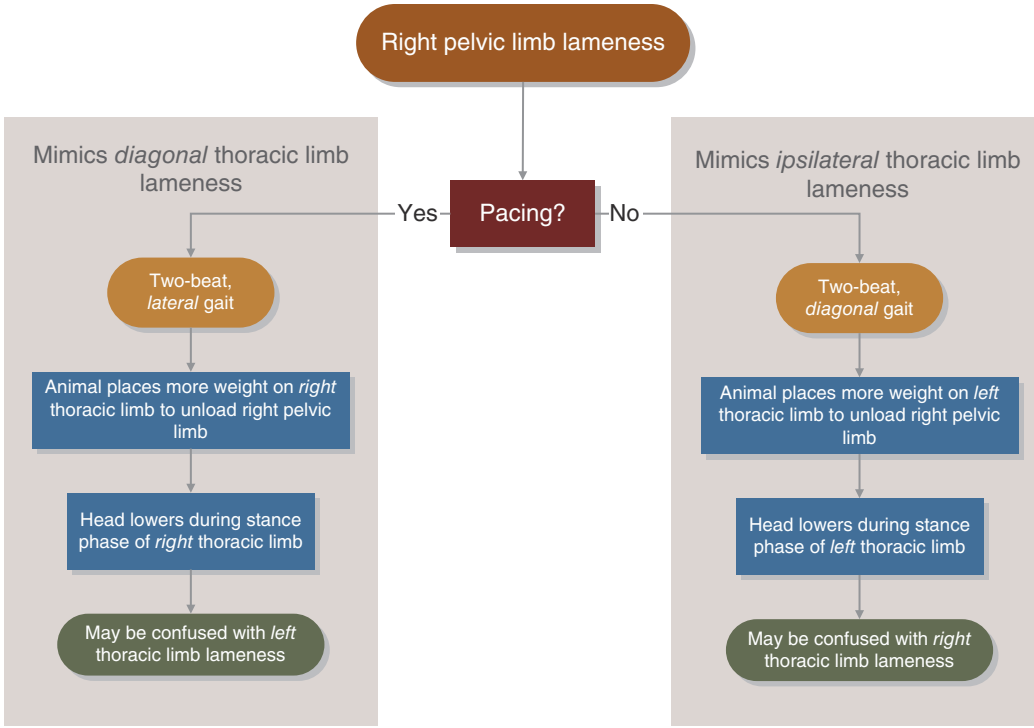

Figure 1.3 Interpretation of head movement for canine pelvic limb lameness comparing trotting (a diagonal gait) and pacing (a lateral gait), illustrating the interpretation of downward movement of the head and neck during stance phase. While this diagram is based on pelvic limb lameness, similarly the observer may confuse a left thoracic limb lameness with a right pelvic limb lameness if the dog paces (and vice versa).

left pelvic limb lameness and vice versa, see Figure 1.3). It is therefore of critical importance that the observer determines if the animal is displaying a diagonal (i.e. trot) or lateral (i.e. pacing) gait.

Pelvic movement, also termed the pelvic or hip hike, is displayed by animals with pelvic limb lameness. The animal will attempt to reduce the amount of weight placed on the affected leg by elevating the pelvis of the affected side, thereby shifting its body weight to the unaffected limb(s). This may be more difficult to observe in long-haired dogs. In dogs with a high-grade lameness, a significant drop of the pelvis is observed when the unaffected limb contacts the ground (Videos 1.1 and 1.4). In horses, it is described that the limb with the greater movement of the pelvis rather than the absolute height determines the lame leg (Baxter and Stashak 2011). Another feature allowing canines to shift their weight to the affected limb is excessive tail movement, generally observed swinging up when the affected limb contacts the ground.

Video 1.4:

Pelvic limb lameness – bilateral CCLD.

To differentiate whether a head nod is arising from a thoracic limb or pelvic limb lameness during subjective gait analysis, the following criteria can be applied: *thoracic limb lameness* – a pelvic hike is

only rarely present*; pelvic limb lameness* – generally impairment is so severe that off-weighing at the stance can also be observed, the dog's body weight is shifted forward resulting in a lower head and neck carry age than usual, and obvious clinical exam findings (e.g. stifle instability) are present.

Multiple limb lameness provides a greater diagnostic challenge. In some cases, identification of specific patterns clearly indicates that multiple limbs are involved. For example, a dog presenting with a severe right pelvic limb lameness would be expected to display a downward movement of the head on the left thoracic limb in the trot. If a downward movement is observed during weight-bearing of the right thoracic limb, this indicates that the animal is also suffering from a left thoracic limb problem. If the animal is simultaneously suffering from an ipsilateral thoracic limb and pelvic limb lameness, an exaggerated head nod will be observed. In horses, the concept of *compensatory* (also termed secondary or complementary) lameness is well established. This lameness is defined as pain secondary due to overloading of the unaffected limb. It is difficult to differentiate compensatory lameness from a primary cause. In general, the most severe lameness should be addressed primarily; however, evaluation of all affected limbs is indicated.

While the above concepts are described for a diagonal gait, similar concepts can be applied if the animal is unable to trot (i.e. during walking). The observer should look for off-loading of specific limbs, decreased stance phase, head nod, and pelvic hike. Following the simple concept, that animals will try to shift their body weight away from the lame limb, helps identify the most affected limb.

1.3.4 Lameness Characteristics

In horses, the stride is divided into the cranial and caudal phase, which is the length of the stride of the affected limb cranial or caudal to the stance position of the contralateral limb (Ross 2011). In other words, the cranial phase of the stride is the phase in front of the hoofprint of the opposite limb (Baxter and Stashak 2011). Lame horses frequently have a decreased cranial stride phase and a lengthened caudal phase; however, the overall stride length is not changed with lameness. This makes clinical sense since a unilaterally decreased stride length would not allow for movement in a straight line (Ross 2011), unless the changes are symmetric. Little is known regarding stride phases and lameness distribution in dogs and some misconceptions about it (e.g. that orthopedic disease in canines always results in a decreased stride length) have been presented in the literature. Clearly, further work in this area is needed but it is intuitive that an animal with bilateral coxofemoral arthritis will show a decreased swing phase (to avoid pain during full range of motion) resulting in the classic short-strided gait (Video 20.2). Additionally, it is important to note that decreased stride length is not pathognomonic for orthopedic disease but is also seen with neurologic conditions (e.g. lower motor neuron disease; Chapter 4). This overlap between orthopedic and neurologic causes can make differentiating the cause of lameness difficult. Therefore, careful neurologic and orthopedic examinations are critical to confirm or exclude neurologic dysfunction.

In horses, supporting limb and swinging limb lameness are further differentiated. A supporting limb lameness is observed when the foot first contacts the ground and indicates conditions of the lower limb (a parallel example in canines would be a dog with a digit fracture). In contrast, the definition of swinging limb lameness is not as clearly defined and varies between equine texts. Ross (2011), for example, describes swinging limb lameness as a non-painful lameness, rather than a lameness during swing phase. Using this definition, canine infraspinatus contracture makes for a good example of a correlate in dogs. However, some equine clinicians attribute a swinging limb lameness to conditions of the upper limb (Baxter and Stashak 2011); when using this definition, canine supraspinatus or biceps tendinopathy makes a good canine correlate.

1.3.5 Lameness Grading

While there are many grading systems to score lameness subjectively, none of them have been validated or used consistently in canine orthopedics. The most commonly used grading scale in horses is the American Association of Equine Practitioners (AAEP) system (Ross 2011): 0 = no lameness; 1 = inconsistent lameness under specific circumstances only; 2 = consistent lameness under specific circumstances only; 3 = consistent lameness at a trot; 4 = consistent lameness at a walk; and 5 = most severe lameness. While this scoring system simplifies the grading, it makes things potentially confusing because it grades lameness at both the walk and trot.

Various grading systems have been proposed to score severity of lameness in dogs, including the use of numerical rating scales (NRS) and visual analog scores (VAS). NRS describe the lameness in descriptive terms such as sound and non-weight-bearing using scales of up to 11 points (Van Vynckt et al. 2011). Although larger scales allow for differentiation of more subtle lameness, this results in less consistency between multiple observers (such as multiple veterinarians within one practice). Therefore, simple scales (Table 1.1) that allow subjective comparison within or between observers and temporal periods (i.e. if different examiners evaluate a patient at different time points) are preferable to use. VAS provide an assessment of continuous limb function. This is accomplished by asking the observer to mark the severity of lameness along a line (generally divided into 100 increments). The results are recorded as continuous variables (Quinn et al. 2007). It is well known that subjective gait analysis varies between observers and correlates poorly to objective gait analysis (Quinn et al. 2007; Waxman et al. 2008). Ideally, objective gait analysis would be used to provide a quantitative analysis; however, given the lack of its availability, an effort should be made to at least use a consistent scoring system by all healthcare professionals within one institution.

Table 1.1 Unvalidated numerical rating score used by the author to subjectively quantify canine lameness.

Score	Lameness degree	Lameness description
0	None	*No identifiable lameness* Weight-bearing at all times
1	Slight	*Inconsistent lameness* that is difficult to observe and/or it is difficult to determine the affected limb (i.e. no consistent head movement/pelvic tilt is observed) Weight-bearing at all times
2	Mild	Clearly detectable lameness associated with minor *head movement/pelvic tilt* Weight-bearing at all times
3	Moderate	Clearly detectable lameness associated with obvious *head movement/pelvic tilt* Weight-bearing at all times
4	Severe	Clearly detectable lameness associated with obvious head movement/pelvic tilt *Occasionally non-weight-bearing/toe touching*
5	Non-weight-bearing	*Always non-weight-bearing/toe touching*

This scoring system can be applied at the walk and/or the trot depending on the patient's clinical status. The patient should only be scored during motion (i.e. off-loading at a stance is not included in this assessment). To increase the sensitivity, the scoring system can be applied for both gaits. If a comparison between different time points is performed, only the scoring within one gait can be compared.

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