THEME

Musculoskeletal medicine

Gait and posture

Assessment in general practice

Kent Sweeting

BHlthSc(Pod)(Hons), MAPodA, is a podiatrist, Brisbane, and a researcher, Griffith University, Queensland. k.sweeting@griffith.edu.au

Michael Mock

MBBS, MMed(PhysMed), FRACGP, FACPM, is a general practitioner, Wetherill Park and St Leonards, New South Wales.

BACKGROUND

A basic analysis of a patient's gait and posture provides information about the body and the capability of the musculoskeletal system to adjust to physical stressors. An understanding of normal gait and posture is essential for identifying and treating musculoskeletal pain.

OBJECTIVE

This article discusses normal gait and how to assess gait. It also outlines common musculoskeletal conditions and their association with abnormal gait and posture. General practitioners can detect faulty postural syndromes and abnormal gait by visual scanning and awareness of pain referral patterns.

DISCUSSION

Awareness of pain that can arise from faulty gait and posture will assist GPs to shift their focus away from structural diagnoses and unhelpful radiological investigations. The GP can become an effective facilitator of the prevention and rehabilitation of pain problems where abnormal gait and posture are found to be a main contributing factor.

Gait analysis is comparable to an X-ray or blood test; it is a powerful investigative tool, which together with the patient history and physical examination, may be used to assess and diagnose patients suffering musculoskeletal pain, and predict successful treatment of these pathologies.[1–3] Understanding the basic principles of normal gait provides a foundation for understanding pathological and compensatory gait deficits.[4] This article will focus solely on visual gait analysis as this can be performed by general practitioners quickly and without expensive equipment.

The lower limbs and pelvis have three main functions throughout the gait cycle:

- shock absorption as the heel strikes the ground
- maintainence of stability while superior segments are changing position and posture, and
- propulsion.

All of these functions are carried out in the most energy efficient manner possible.[5] The gait cycle (or one complete stride which is measured from initial heel strike to the ipsilateral heel strike) can be divided into two periods – stance and swing. The normal distribution of time spent in these two periods is approximately 60% and 40% respectively.[5] *Figure 1* summarises all events and the timing of just over one complete gait cycle. When examining gait, clinicians can fall into the trap of solely focusing on the stance phase and miss vital pieces of information that can be gathered from the patient's swing phase (eg. hip drop of the nonweight bearing hip). Similarly, one can mistakenly rely on observation of gait in just one plane (eg. coronal plane).

There is no one correct manner for assessing gait. It is important however, to develop a systematic approach. This author prefers a 'head to toe' approach for observing anatomical and functional features in all three planes:

- head position
- shoulders
- arm swing
- spine
- pelvic tilt
- hip range of motion
- knee
- tibial shank
- ankle motion
- heel position (heel strike and heel off)
- rear foot position relative to the ground
- navicular tuberosity

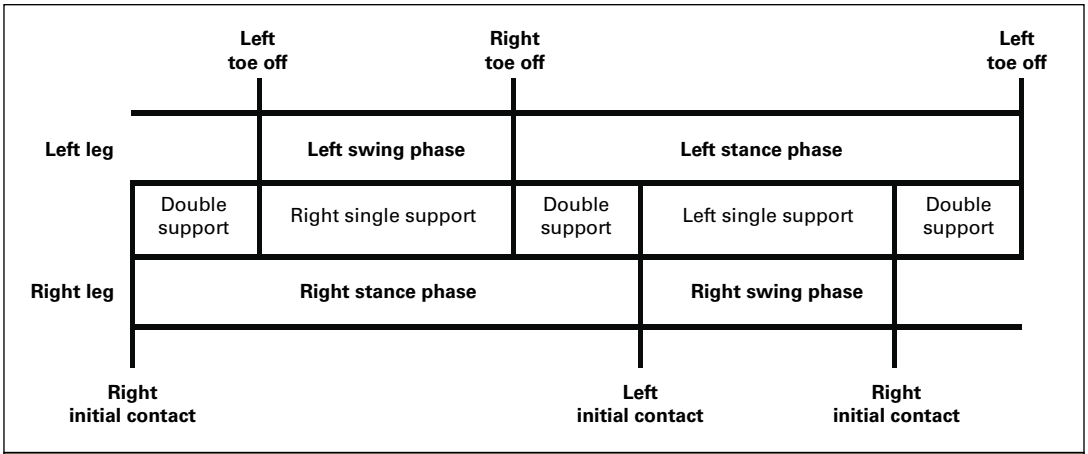


Figure 1. Timing of events during just over one complete gait cycle starting with right initial contact

Figure 2. Patient with anterior pelvic tilt in late mid stance (double support)

- lateral midfoot
- metatarsals
- first metatarsophangeal joint range of motion
- digits
- overall foot and leg position
- muscle activity.

Often the best time to examine a patient's gait is as they are entering the examination room as they are less likely to act unnaturally. More thorough gait assessments can be done with the patient walking up and down a walkway of at least 6 metres or on a treadmill. A more detailed explanation of normal gait can be found in many texts.[2,5–7]

Abnormal gait

Musculoskeletal disorders comprise an important public health problem due to high impact on disability, sickness absence and work disability, and health care costs.[8–11] A recent Dutch population study showed that 75% of the population aged 25 years and over reported musculoskeletal pain in the previous 12 months and almost 45% of people reported pain lasting longer than 3 months.[8] Unlike most health problems, musculoskeletal pain is very prevalent among the younger age groups.[8] In Great Britain from 1994 to 1995, musculoskeletal diseases accounted for almost 224 million sick days – the number one cause of sick days.[9] Awareness of pain that can arise from abnormal gait will help the GP become effective in the prevention and rehabilitation of pain problems where abnormal gait is found to be a main contributing factor.

When assessing gait, it is important to understand that a problem affecting one body part can lead to problems elsewhere. A deformity in one part will be compensated in another. Due to the complex interactions of human body parts in movement, there is limited research showing causation between abnormal gait and posture and musculoskeletal pain. At a time where evidence based practice is a growing trend, clinicians working predominantly in this area (eg. podiatrists, physiotherapists and musculoskeletal physicians) must balance this with empirical evidence. Following is an example of how a common painful condition may result from abnormal gait and posture.

Knee pain resulting from abnormal pelvis mechanics

Description

A common presentation to practitioners is anterior knee pain. The most common diagnosis of anterior knee pain is patellofemoral pain syndrome.[12] Patellofemoral pain syndrome is characterised by an insidious onset of anterior or retropatellar pain exacerbated by prolonged sitting, stair climbing, squatting or running.[12] It affects up to 25% of people participating in sporting activities.[13] Patellofemoral pain syndrome may result from abnormal mechanics distal to the knee such as excessive rear foot pronation or abnormal mechanics proximal to the knee such as excessive anterior pelvic tilt (or a combination of both proximal and distal abnormalities).[5–7]

Assessment

A patient with excessive anterior pelvic tilt displays weak gluteus medius, gluteus minimus and rectus abdominis, while having tight hip flexors (ie. iliopsoas, rectus femoris) leading to an increased lumbar lordosis (see pelvic cross syndrome discussed later). The increased anterior pelvic tilt causes greater knee flexion at heel strike and mid stance (>20 degrees is considered abnormal knee flexion when walking – seen in the sagittal view when examining gait)[7] to support the forward leaning trunk (*Figure 2*). Increased knee flexion causes the patella to compress against the femur with greater force, predisposing the patient to patellofemoral joint syndrome.[6]

Management

Initial treatment consists of analgesia and appropriate referral to a practitioner (eg. podiatrist or physiotherapist) for thorough assessment, identification and treatment of causal factors. When the causal factors of anterior knee pain are treated (eg. by pelvic stability and hip flexor stretching) long term pain relief may be achieved.[12] Orthopaedic opinion should be sought for patients not responding to conservative management.

Posture

There are three tasks of postural control:[14]

- antigravity function – ie. maintenance of upright posture and keep eyes level
- maintenance of equilibrium, and
- providing mechanical support for motor action.

Optimal posture

Optimal posture implies balanced distribution of body mass around the centre of gravity where the compression force on spinal discs is balanced by ligamentous tension and there is minimal energy expenditure from postural muscles.[15]

A quick visual scan by the GP will detect significant asymmetries in posture – presence of head tilt, unlevelling of shoulders, pelvis or scoliosis (back view); forward head carriage where ear lobes are anterior to shoulders, exaggeration of spinal curves (side view). For more detailed visual criteria see *Diagnosis of muscular dysfunction by inspection*.[16]

Factors contributing to postural abnormalities

- Congenital or acquired structural changes (eg. idiopathic scoliosis, deformed vertebra, foot and ankle abnormalities)
- Abnormal gait (eg. pes planus, leg length discrepancy [*Table 1*])
- The commonest cause according to Janda (neurologist, rehabilitation physician and researcher of muscle function analysis) is muscle imbalance arising from modern lifestyle with constrained postures from repetitive tasks and limited range in movement and inactivity.[17–20]

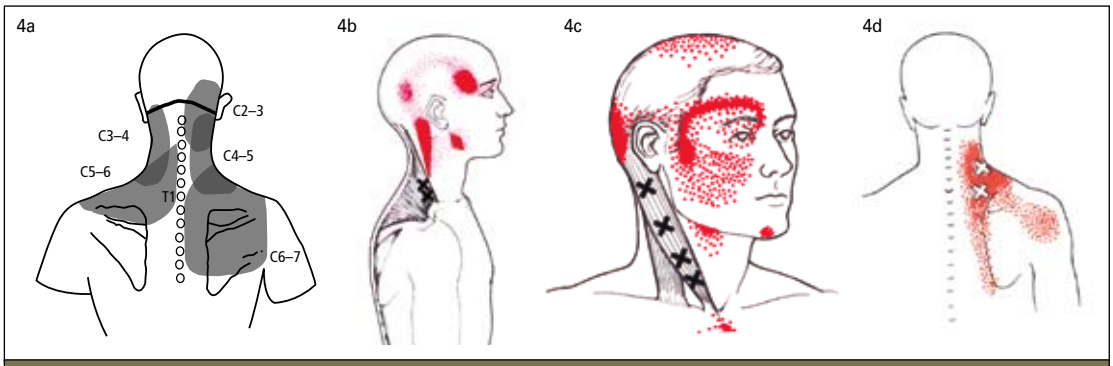
Table 1. Common signs of leg length discrepancies seen in gait

Body part	Gait manifestation
Shoulder	Dropped on the longer side
Arm	Abducted arm swing on the longer side
Pelvis	Higher on the longer side (especially noticeable in swing phase)
Leg	Circumduction on the longer side in swing
Knee	Excessive flexion on the longer side in swing to allow ground clearance
Foot	Out toe on the shorter side

Table 2. Shoulder (proximal) cross syndrome

Muscle imbalances		Characteristic posture
Tight/shortened (postural) muscles	**Weak/inhibited (phasic) muscles**	
Upper shoulder girdle fixators: • upper trapezius • levator scapulae • scalenes	Lower shoulder girdle fixators: • middle trapezius • lower trapezius • rhomboids • serratus anterior	Elevation of shoulders
Shoulder girdle protractors: • pectoralis major • pectoralis minor	Shoulder girdle retractors: • rhomboids • middle trapezius • lower trapezius	Protraction of shoulders
Neck extensors: • short neck extensors • sternocleidomastoid • upper trapezius • levator scapulae	Deep neck flexors: • longus coli • longus cervicis • longus capitis	Head forward posture Increased cervical lordosis Hyperextension of upper cervical joints

Figure 3. Shoulder (proximal) cross syndrome: head forward posture – ear lobes anterior to shoulder, protracted shoulders, increased kyphosis of cervicothoracic junction, increased cervical lordosis



4a. Referred pain from cervical spine

Reproduced with permission: Dwyer A, Aprill C, Bogduk N. Cervical zygapophysial joint pain patterns. 1: a study in normal volunteers. Spine 1990;15:453–7

4b. Referred pain from upper trapezius

Reproduced with permission: Travell JG, Simons DG. Myofascial pain and dysfunction. The trigger point manual. Baltimore: Williams & Wilkins, 1993

4c. Referred pain from sternomastoid

Reproduced with permission: Travell JG, Simons DG. Myofascial pain and dysfunction. The trigger point manual. Baltimore: Williams & Wilkins, 1993

4d. Referred pain from levator scapulae

Reproduced with permission: Travell JG, Simons DG. Myofascial pain and dysfunction. The trigger point manual. Baltimore: Williams & Wilkins, 1993

Janda's postural syndromes

'Muscle imbalance' refers to the tendency of certain muscles to become tight, hypertonic, and activating earlier and more readily in movement patterns whereas other muscles are more likely to exhibit hypotonia, inhibition, weakness, atrophy and activate less readily and later in movement patterns. This tendency is not random but occurs in a predictable and recognisable pattern. The tight, hypertonic muscles have predominately antigravity function during gait whereas their antagonists tend toward weakness and inhibition.[17–20]

Muscle imbalances result in faulty postures, joint malalignment and development of altered inefficient movement patterns resulting in strain and degeneration of joints, myofascial and ligamentous structures.[17–21]

There are two commonly seen postural syndromes whose characteristics have been described by Janda from observations from clinical studies:

- shoulder (proximal) cross syndrome – involving head and shoulder girdles (*Table 2, Figure 3, 4a–d*)
- pelvic (distal) cross syndrome – involving lower back and hip girdles (*Table 3, Figure 5, 6a–d*).

Shoulder cross syndrome

Postural presentation

See *Figure 3*.

Possible symptoms

Cervical dysfunction – painful reduction in range of movements with local or referred axial neck pain, occipital, frontal, temporal and posterior shoulder pain from articular strain, myofascial and ligamentous strain (*Figure 4a–d*).

Shoulder dysfunction – protraction of the shoulder and poor scapular stabilisation results in malalignment of the head of the humerus with the glenoid fossa causing tautness in superior anterior shoulder capsule, supraspinatus and posterior fibres of deltoid muscles. These imbalances over time result in impingement syndromes and rotator cuff dysfunctions. Muscles of the shoulder and cervical region have a stabilising function and arm elevation requires a fixed point (shoulder). Muscle imbalance moves the fixed point to the head and neck causing additional stress on cervical spine.

Pelvic cross syndrome

Postural presentation

See *Figure 5*.

Possible symptoms

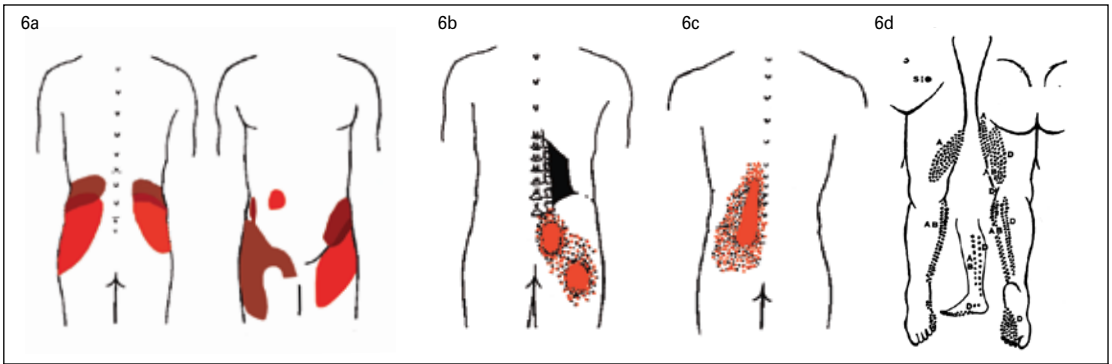
Back and leg pain from the following proposed mechanisms:

- increased lumbar lordosis causing increased pressure on the posterior portion of the disc, jamming of lumbar facet joints especially L5/S1 and ligamentous strain and myofascial dysfunction (*Figure 6a–c*)
- sacroiliac joint dysfunction from alteration of lumbopelvic mechanics (lateral shift and anterior pelvic tilt). Pain referral to lower back and leg (*Figure 6d*)
- altered gait.

Figure 5. Pelvic cross syndrome: hyperlordosis, protruberant abdomen, forward leaning of body, increased forward tilt of pelvis

Table 3. Pelvic (proximal) cross syndrome

Muscle imbalances		Characteristic posture
Tight/shortened (postural) muscles	**Weak/inhibited (phasic) muscles**	
Hip flexors: • iliopsoas • rectus femoris	Hip extensors: • gluteus maximus	Increased lumbar lordosis Increased forward tilt of pelvis
Lumbar extensors: • lumbar erector spinae	Lumbar flexors: • rectus abdominis	Protuberant abdomen
Substitute hip abductor: • tensor fascia lata Pelvic elevator: • quadratus lumborum	Hip abductor: • gluteus medius • gluteus minimus	Unlevelling of iliac crest from pelvic tilt Lateral pelvic shift (seen in static posture and especially during gait)



6a. Referred pain from lumbar spine joints
6b. Referred pain from quadratus lumborum muscle
6c. Referred pain from psoas muscle
6d. Referred pain from posterior sacroiliac ligament (sacroiliac joint instability)
Reproduced with permission: Hackett G. Ligament and tendon relaxation. Beulah Land Pres

Proposed diagnostic and management approach

Janda suggests these syndromes are the cause of the bulk of atraumatic spine, shoulder and pelvic girdle pain in patients that present to the family doctor seeking pain relief. The following is a suggested diagnostic and management approach by the GP.

History

- Patient presents with gradual onset of regional pain with a recognisable pain referral pattern (*Figure 4a–d, 6a–d*)
- Postural history of constrained postures from repetitive tasks and sedentary lifestyle
- Absence of features of serious pathological conditions (red flags).[22]

Examination

- Presence of typical postural abnormalities on visual inspection (*Figure 3, 5*)
- Absence of red flag signs.

Investigations

- No imaging required.[22]

Management

- Provide information and assurance and encourage normal activities
- Referral to a manual therapist or, in complex cases, to a musculoskeletal physician for assessment and treatment with aim of correcting muscle imbalance and establishing a more economical movement pattern which will result in pain relief
- Correction of poor ergonomic factors
- Regular stretch and exercise routine to maintain improvement (eg. pilates, tai chi, yoga, aquaerobics with specific emphasis on strengthening of core muscles[23] to provide lumbopelvic stability).

Currently, there is limited research evidence to support Janda's paradigm. However, manual therapists (physiotherapists, osteopaths and chiropractors) incorporate Janda's paradigm into their treatment

strategies. Travell and Simons' trigger point referral maps have been included so that GPs may appreciate the myriad of pain referral patterns that can arise from 'muscles in shortened positions which can activate a latent trigger point'[24] (*Figure 4*) and frequently seen in clinical practice in association with postural syndromes.

Conclusion

Gait and posture analysis is a powerful investigative tool that can be used by GPs to assist in the assessment, diagnosis and management of patients with musculoskeletal pain. Addressing the underlying causes of the patient with pain resulting from gait and posture abnormalities is important in obtaining long term pain relief.

Summary of important points

- Gait analysis is an important tool for the GP to assist in assessing and diagnosing musculoskeletal pain.
- Common lower limb pathologies may result from abnormal biomechanics; the sources of which may be proximal or distal from the area of pain.
- Optimal posture requires minimal energy expenditure from postural muscles.
- Muscle imbalances result in faulty postures, joint malalignment and development of altered uneconomical movement patterns resulting in overstrain and degeneration of joints, muscles and ligaments.
- No radiology is required to diagnose postural syndromes. General practitioners can diagnose via pattern recognition of typical faulty posture and its pain referral patterns.
- Re-establishing core muscle (transversus abdominus, pelvic floor muscles and multifidus) strength is essential for lumbopelvic stabilisation and prevention of recurrence of pelvic cross syndrome.

Conflict of interest: none declared.

References

1. Harris GF, Wertsch JJ. Procedures for gait analysis. Arch Phys Med Rehabil 1994;75:216–25.
2. Whittle MW. Gait analysis: an introduction. 3rd edn. Edinburgh: Butterworth Heinemann, 2002.
3. Whittle MW. Clinical gait analysis: a review. Hum Mov Sci 1996;15:369–87.
4. Curran SA, Dananberg HJ. Future of gait analysis: a podiatric medical perspective. J Am Podiatr Med Assoc 2005;95:130–42.
5. Perry J. Gait Analysis: normal and pathological function. New Jersey: Slack Inc, 1992.
6. Bruckner P, Khan K. Clinical Sports Medicine. 2nd edn. Sydney: McGraw–Hill, 2001.
7. Valmassy RL. Clinical biomechanics of the lower extremities. St. Louis: Mosby, 1996.
8. Picavet HSV, Schouten JSAG. Musculoskeletal pain in the Netherlands: prevalence, consequences and risk groups, the DMC3-study. Pain 2003;102:167–78.
9. Moncrieff J, Pomerleau J. Trends in sickness benefits in Great Britain and the contribution of mental disorders. J Public Health Med 2000;22:59–67.
10. Meerding WJ, Bonneux L, Polder JJ, Koopmanschap MA, van der Maas PJ. Demographic and epidemiological determinants of healthcare costs in Netherlands: cost of illness study. BMJ 1998;317:111–5.
11. Leijon M, Hensing G, Alexanderson K. Gender trends in sick listing with musculoskeletal symptoms in a Swedish county during a period of rapid increase in sickness absence. Scand J Soc Med 1998;26:204–13.
12. Tyler TF, Nicholas SJ, Mullaney MJ, McHugh MP. The role of hip muscle function in the treatment of patellofemoral pain syndrome. Am J Sports Med 2006;34:630–6.
13. Stefanyshyn DJ, Stergiou P, Lun VMY, Meenuwisse WH, Worobets JT. Knee angular impulse as a predictor of patellofemoral pain in runners. Am J Sports Med 2006;34:1844–51.
14. Bronstein A, Brandt T, Woollacott M, Nutt J. Clinical disorders of balance, posture and gait. 2nd edn. Ch 1. London: Arnold, 2004.
15. Levit K. Manipulative theory in rehabilitation of the locomotor system. 3rd edn. Oxford: Butterworth-Heinemann, 1999.
16. Vasilyeva L, Lewit K. Rehabilitation of the spine. Practitioner's manual. Liebenson C, editor. Baltimore: Lipincott Williams & Wilkins, 1996;113–6.
17. Janda V. Pain in the locomotor system. Proceedings from Second Annual Interdisciplinary Symposium – Rehabilitation in Chronic Low Back Disorders. Los Angeles, 1988.
18. Janda V. Muscles and joint correlations. IVth Congress FIMM. Prague, 1975. Rehabilitation supplement 10/11, 154–8.
19. Janda V. Muscles as a pathogenic factor in back pain. 'IFOMT' (International Federation of Orthopaedic Manual Therapists). New Zealand, 1980.
20. Janda V. Evaluation of muscular imbalance. In: Liebenson C, editor. Rehabilitation of the spine. Baltimore. Lippincott Williams & Wilkins 1996;97–112.
21. Sahrmann SA. Diagnosis and treatment of movement impairment syndromes. China: Mosby, 2002;1–8.
22. Australian Acute Musculoskeletal Pain Guidelines Group. Evidence based management of acute musculoskeletal pain: a guide for clinicians. Australia: Australian Academic Press, 2004.
23. Richardson C, Hodges P, Hides J. Therapeutic exercise for lumbopelvic stabilisation. 2nd edn. Sydney: Churchill Livingstone, 2004.
24. Simons D, Travell J, Simons L. Myofascial pain dysfunction. The trigger point manual. Vol 1, 2. 2nd edn. Maryland: Williams & Wilkins, 1999.

afp **CORRESPONDENCE** email: afp@racgp.org.au