CHAPTER 1

Musculoskeletal physiotherapy

Introduction

Gait analysis or assessment is a skill that requires close observation of the patient at walk and trot, to determine the cause and location of the lameness. A start point is to become familiar with a *normal* gait pattern, taking into account breed variations (i.e. dachshund vs bull mastiff). Once you are familiar with normal gait pattern, any deviation from this can be recognised.

Animals should be on a loose lead at walk and trot to observe for anatomical symmetry (normal gait pattern). Animals should be observed in a straight line towards, and then a straight line away from the observer. Pay particular attention to how the animal turns to both the left and right side – this may show reluctance to transfer weight onto the affected limb, or that the animal has issues with balance. The observer should then view the animal moving from both left and right sides. Subtle lameness may not readily be observed at walking pace; however, at trot the animal will only have one thoracic limb and one pelvic limb in contact with the ground, and these limbs will be placed under greater pressure meaning a lameness may be easier to detect.

Practical Physiotherapy for Veterinary Nurses, First Edition. Donna Carver.

Videoing the gait pattern, then slowing it down on playback, may be a useful way to detect lameness.

Gait analysis

Observe muscle symmetry, weight-bearing (paw and toe position) and conformation at rest.

Observe gait in a quiet area at walk and trot; thoracic limb lameness is often associated with head bobbing. When the animal takes its bodyweight through the painful thoracic limb the head will bob upwards in an attempt to unload the ground reaction force passing through the limb.

Pelvic limb lameness can be observed by a *hiking up* in the gluteal region in an attempt to offload or shift weight from the painful limb; this may be towards the contralateral pelvic limb, or forwards usually towards the contralateral thoracic limb. Lameness in pelvic limbs may also present with a *bunnyhopping* gait pattern. This may be related to a reduction in pelvic limb power, often observed with stair climbing or running. The bunnyhopping gait pattern may also be related to a reduced range of motion within the coxofemoral joint, which would be confirmed on physical examination.

Lameness is a general term used to describe an abnormal gait pattern; it may be:

Congenital – chondrodystrophic abnormalities, i.e. valgus (lateral deviation of the distal limb), often seen in dachshunds.

Or

Pathological – related to a disease process such as osteoarthritis, which can affect any breed but is often seen in larger breeds.

Scoring systems are often used to grade the degree of lameness, and in veterinary practice a typical 1–10 scale is used where 1/10 would indicate barely lame, whereas 10/10 would indicate non-weight-bearing lameness. The scale is very subjective, as only descriptive terms

Table 1.1 Lameness scoring scale.

Score	Description
0	Normal
1	Reduced weight-bearing through affected limb in stance
2	Mild lameness at trot
3	Moderate lameness at walk and trot
4	Intermittently carries limb, lame in trot
5	Non-weight-bearing lameness

From Summer-Smith (1993). Reproduced with permission from Elsevier.

are allocated to the very mildest and most severe lameness. If one observer rated lameness as 4/10, then a second observer may rate the same lameness as 6/10; does this indicate the lameness is progressing? This is why it is important to obtain a full and accurate history from the owner, who will probably observe the animal's gait every day and be able to state if the lameness is improving, staying the same, or deteriorating. A simpler alternative scoring 0–5 system is available (Table 1.1).

Elbow dysplasia gait analysis findings include abduction of the affected limb in an attempt by the patient to reduce the amount of bodyweight passing through the elbow joint. This will be most evident when the animal is ambulating on hard ground as the concussive forces passing through the elbow joint will be greater.

Flicking of the carpal joints is also evident with elbow dysplasia; this is a compensatory mechanism for the reduced range of motion, especially elbow flexion, that is characteristic of advanced elbow dysplasia. The condition is often bilateral, so it is important to observe how the animal turns (weight transfer) and observe (or ask the owner about) functional activities such as how or if the animal is able to descend stairs or jump from the car; this will increase load on the elbow joint and will be uncomfortable for the animal so he may avoid these functional activities.

Hip dysplasia gait analysis findings may include a short stride length; this is usually shown as reduced hip extension and can be readily observed as the animal climbs stairs as a weak or short hip extension/push-off. The reduction in hip extension is a characteristic of hip dysplasia, with associated osteoarthritis and joint remodelling.

Adduction of the affected limb is also evident. This can be due to weakness in the hip flexor muscle groups, and may also be associated with secondary osteoarthritic changes and compensatory coxofemoral joint remodelling. As discussed earlier *hiking up* of the gluteals to shift bodyweight from the affected limb, and *bunnyhopping* with bilateral hip dysplasia are also gait characteristics observed with this disease.

Cruciate rupture patients usually present with an abnormal gait pattern. Lameness can vary from mild 1/5 (usually chronic) to 5/5 (usually acute). The degree of lameness often correlates with the level of pain the animal is experiencing. A short stride length, especially reduced extension, is evident; also the animal will tend to limit stifle flexion. The animal will usually guard or resent stifle end-of-range flexion. *Clicking* of the joint may be evident and may indicate associated meniscal damage; this may be evident when the animal flexes the stifle joint, and loads the joint with bodyweight, such as in stair climbing. In acute presentation a joint effusion may be present. In chronic presentations thickening of the joint on the medial surface often with a tibial buttress is common. Stifle range of motion (ROM) is reduced as a result of scar tissue formation and secondary osteoarthritic changes.

The animal may abduct the limb to alter the direction of ground reaction forces passing through the joint, and if there is fatigue or weakness in the hip flexor muscle groups.

The animal will be reluctant to fully weight-bear through the affected limb; at rest, toe touch weight-bearing is often evident; the animal may also adopt various strategies to reduce weight-bearing in stance and will often position the affected limb in a craniomedial plane.

The long-term muscle changes associated with pelvic limb lameness are short, tight hip flexor muscles, with, weak hamstring

muscles. The goal for the physiotherapist is to stretch the short, tight muscles, whilst strengthening the weak, muscles.

History taking

This should include:

1 Age – *Young dogs*: When taking a history consider hip dysplasia, elbow dysplasia, oesteochondrosis dissecans (OCD).

Adult dogs: Consider osteoarthritis, cruciate disease and neoplasia.

2 Breed – *Toy breed*: Often show patella luxation, Legg–Calvé–Perthes disease.

Large breed: May present with cruciate disease, elbow dysplasia, neoplasia.

3 Onset of lameness:
- **a** May be sudden or subtle or traumatic.
- **b** Can be episodic or cyclic.
- **c** Is it consistently the same limb or a shifting lameness?

4 Duration of lameness:
- **a** Can be continuous or intermittent.
- **b** Is the patient's condition deteriorating, remaining static or improving?

5 Association:
- **a** Does exercise or rest effect the condition?
- **b** Does the patient appear worse in the morning or night?
- **c** Is there a seasonal pattern when symptoms are seen in summer or winter?
- **d** Does soft or hard ground affect the severity of symptoms?

6 Behavioural changes:
- **a** Is the patient showing aggression?
- **b** Does the patient have sleep disturbance?
- **c** Is the patient reluctant to play/jump?

7 Exercise – Ask about type, frequency and duration.

8 Response to treatment:
- **a** Is the patient on any medication, has this made any difference?
- **b** Has the patient had any previous physiotherapy treatment? If so what was the response or outcome?
- **c** Explore the owner's expectations of physiotherapy.

Physical examination

When assisting with a physical examination try to find a quiet area. Adopt a systematic anatomical approach each and every time. With the animal standing each limb will be lifted in turn to gauge weight-bearing through the limbs. Obviously the animal will be taking least weight through the affected limb, but lifting each limb in turn may give an indication of where the animal is shifting his bodyweight as a compensatory measure. Compensatory measures can often lead to secondary musculoskeletal issues so these should be noted during the physical exam and addressed later.

When assessing muscle mass compare with the unaffected contralateral limb for muscle mass symmetry. A standard tape measure can be used to measure the circumference of muscle bulk. Again, try to be systematic to ensure accuracy. For example, when measuring pelvic limb muscle bulk try to measure in standing, measure at the thickest point – this usually corresponds to the level of the muscle belly. Try to have a landmark – say in the pelvic limb the greater trochanter of the femur – where the two ends of the tape measure should meet and record the measurement. A difference of more than 1 cm would be considered significant. It is good practice to measure three times and take the average measure from the three readings and record this average reading in the notes.

Conscious proprioception may be delayed or absent in the presence of a joint effusion, which is often evident in acute cranial cruciate ligament injury.

Exercise plans

Exercise plans are designed to rehabilitate patients back to their highest level of function; they can be staged and should be progressive:

- *Early phase* (approximately 0–2 weeks): this time scale will depend on the patient's condition. The aims will be to control inflammation, maintain joint ROM and muscle length.
- *Mid-phase* (approximately 2–6 weeks): during this phase the patient should be progressing. The aims are to build on the progress from the early phase and also to improve strength, balance and proprioception.
- *Late phase* (approximately 6–12 weeks): this stage is when the patient will continue to gain strength, regain balance and improve stamina.

Early stage post-surgical rehabilitation will begin on day 1 postoperatively. Aim to minimise pain and inflammation, ensure non-weight-bearing (NWB) status on affected limb, maintain joint ROM and muscle length.

Mid-stage rehabilitation can commence 14 days postoperatively, following a satisfactory check-up from the veterinary surgeon and suture removal. The aims are to begin to increase joint ROM of the affected limb, and increase muscle length and mass on the affected limb. Begin gentle partial weight-bearing (PWB) exercises to increase function and strength, and prevent secondary compensatory postures and complications from developing.

Late-stage rehabilitation can commence at 6 weeks postoperatively following a satisfactory check-up from the veterinary surgeon, who may take survey radiographs at this stage to check healing. Rehabilitation goals will be to continue to strengthen the muscles of the affected limb. The patient may be full weight-bearing (FWB) on the affected limb at this stage.

Commence balance and proprioceptive exercise training using wobble cushions, wobble boards and cavaletti pole work. Address compensatory postures, which may be associated with trigger points.

Address secondary complications such as muscle imbalances (tight in flexor muscle groups, weak in extensor muscle groups, which is a common finding in animals with long-term lameness). Finally, the aim of the rehabilitation programme is to return the patient back to the highest level of function, so late-stage rehabilitation will address cardiovascular fitness or stamina, which will have been effected by the graded return to function rehabilitation programme.

Also consider the owner's ability and commitment to carry out the rehabilitation programme, plus environmental factors. The owner may work full time and have other family commitments. The rehabilitation home exercise programme should fit in with the animal's needs and the owner's time restrictions. Do not advise a rehabilitation home exercise programme that takes any more than 30 minutes twice daily to ensure owner compliance. Environmental factors to consider would include: are there other animals in the house, and are there stairs in the house that the patient needs to use?

Physiotherapy treatment techniques and modalities

Cold therapy

Cold therapy aims to control and minimise inflammation postoperatively or following acute injury. The body responds to injury by triggering an inflammatory reaction in the cells. The normal inflammatory phase in healthy tissues is approximately 72 hours. This is the period of time when cold therapy is recommended to minimise the inflammatory response.

Signs of inflammation

- *Pain* – from swollen or damaged nerve endings.
- *Redness* – from damage of local tissues.
- *Heat* – from dilation of local blood vessels.
- *Swelling* – from the associated capillaries becoming more permeable resulting in oedema of the local area.

Cold can be applied to the affected area in several ways. Broken ice chippings wrapped in a plastic zip-lock bag covered by a damp cloth, applied to the affected area for 10–20 minutes can be effective. This treatment can be repeated every 4–6 hours as required.

Usually begin the treatment early to minimise the inflammatory response. If an animal is recovering from surgery and is hypothermic, treatment may be postponed until the patient's body temperate returns to normal.

Cold therapy works by causing vasoconstriction of the local damaged blood vessels, thereby reducing swelling, damage to local tissues, and oedema.

Contraindications

- Cold hypersensitivity.
- Altered skin sensation.

Cautions

- Cardiac conditions.
- High blood pressure.
- Open healing wounds.
- Areas over superficial nerves.

Heat therapy

Various methods can be used to apply heat to the superficial tissues, such as wheat bags and heat discs that can be warmed in the microwave. Alternatively a damp towel can be microwaved, placed in a zip-lock bag and applied to the affected area for 10–20 minutes. This can be repeated every 4–6 hours.

Heat therapy can commence once the inflammatory phase has passed (usually 72 hours post-injury).

The principle of heat therapy is to vasodilate local blood vessels thus increasing blood flow to the local area to promote healing. Increased cellular activity results in an increase of oxygen and nutrients delivered to the cells.

Heat therapy can be used to reduce pain, stiffness and muscle spasm. Heat improves the elasticity of tissues and can be use prior to stretching.

Contraindications

- Sensory changes.
- Burns/scalds.
- Thrombus/embolism.
- Hyper- or hypo-sensitivity to heat.
- Infections.
- Malignant tumours.

Positioning and supports

Positioning aids and supports are used to maintain muscle length and support the weight of the affected limb. The animal may not have full function or control of the affected limb postoperatively. This may be exacerbated by factors such as pain or discomfort, bulky dressings or external fixators.

The animal will usually choose not to lie on the same side as the affected limb. However, the animal may find it difficult to find a comfortable position in which to rest. In most circumstances the animal will be more comfortable if the affected limb is supported in a neutral position, or slightly elevated in the early stages of recovery, and this will also prevent any muscle imbalances from developing. Folded beds, towels and pillows can be used to maintain the required position. Gentle handling and support of the affected limb and reassuring the animal are essential to aid compliance.

If a patient is placed with the injured limb uppermost and appears uncomfortable, or if the animal continually changes his position to lie on the injured limb, leave the animal in this position as he obviously finds it more comfortable. However, it is preferable not to allow the animal always to lie on one side, so attempt to gently reposition the

animal on his non-affected side even if he only tolerates this position for a short period.

Ensure that if the patient's trunk is positioned in sternal recumbency and the patient has a support at his lateral thorax so he is not weight-bearing excessively or unevenly through his elbow joints. Ensure the elbows are equally abducted to prevent uneven weight-bearing, which could result in pressure sores. If the affected limb is positioned uppermost an adductor wedge or internal rotator wedge should be placed between the limbs to prevent muscle imbalance – for instance, weak gluteals versus tight adductors. Aim to use the adductor wedge to place the affected limb in a neutral position as this will be most likely tolerated by the patient.

Many waterproof animal mattresses are available to assist in preventing pressure sores. However, this will create an unstable surface when the animal is standing, and walking in and out of the kennel. Position yourself on the opposite side of the affected limb when assisting the patient to stand and walk in and out of the kennel. When positioned on the unaffected side you are able to assist the animal to shift his weight onto his unaffected limb to ensure he does not lose his balance.

Manual aids

Slings

Slings are used to assist the animal when he is mobilising. A variety of slings are available for veterinary use, most commonly used with orthopaedic patients is The Soft Quick Lift™ (Four Flags Over Aspen, Inc.) abdominal sling. This type of sling is useful following pelvic limb surgery, is easy to use, and is usually well tolerated by the patient. If you are using a sling to assist the patient to mobilise, position yourself on the same side as the unaffected limb in line with the pelvic limb. In this position you can tilt the patient slightly onto his unaffected limb and assist with balance if necessary and prevent him from falling.

In the early stages following orthopaedic surgery it is not desirable for a patient to weight-bear on the affected limb. This is because the soft tissues and bones are still healing, stabilising and remodelling. *Early weight-bearing is not a sign of successful surgery*. The sling is used in much the same way that a human would use crutches following surgery to a pelvic limb. The crutches are used to *protect* the limb whist healing takes place until a bony callus forms; the implant used to stabilise the joint is not strong enough to allow the individual to bear full weight through the affected limb.

A Helping Hand pelvic support sling (Mikki, Dorking, Surrey, UK) is sometimes used to support orthopaedic patients postoperatively when they are mobilising. A Helping Hand can be more difficult to place on the patient, it may be easier to assist the patient to stand, then whilst supporting him, position his feet in the limb holes of the Helping Hand and then pull them up, secure with Velcro and fasten the clips.

A Helping Hand sling is preferred to The Soft Quick Lift™ sling for animals undergoing pelvic or hip surgery as it gives added support to the pelvis and does not *block* hip flexion movements. A Helping Hand sling would also be the support aid of choice for thoracic limb post-surgical support. Given that the dog bears 60% of his bodyweight through the thoracic limbs support of the thoracic limbs to allow healing to take place is even more crucial.

For animals with multiple trauma to several limbs a fully body sling and mobile hoist may be necessary to assist mobilisation. The body sling supports the animal's trunk, whereas the hoist supports the animal's bodyweight; the hoist is slowly moved forwards and the animal can move his limbs without taking very much of his body weight.

Electrotherapy

Electrotherapy can be a useful modality when used in conjunction with therapeutic rehabilitation exercises.

Pulsed electromagnetic energy (PEME; Biomag® therapy)

The unit consists of a control panel and an electronic waterproof pad that can be placed under the affected area to be treated. It is a non-invasive treatment and as such is usually well tolerated by the patient. It is especially useful for treatment in arthritic patients and uses pulsed magnetic therapy to reduce pain and inflammation. PEME can be used in both the acute and chronic phases of disease. Pulsed magnetic therapy has been used in the assistance of bone healing.

Class IV laser

This can be used to treat wounds, for chronic and acute musculoskeletal conditions, for soft tissue injures, for pain and to control oedema (Figure 1.1). Power settings and the duration of treatment are calculated according to species, skin colour, bodyweight, area to be treated and the stage of the condition (acute or chronic). *N.B. Eyes must be protected with dark-green lens glasses*.

Contraindications of laser therapy

- Do not use laser therapy in pregnant animals.
- Do not use laser therapy to treat animals' eyes.
- Do not use laser therapy in animals with neoplasia.
- Do not use laser therapy over the thyroid area.

Transcutaneous electrical nerve stimulation (TENS)

This consists of a small control box, with wires leading to electrode pads. It is used to reduce pain by transmitting small electrical pulses to the affected area via the electrode pads.

The transcutaneous electrical nerve stimulation (TENS) machine can be used at a frequency of 90–130 Hz to stimulate large nerve fibres that activate the inhibitory interneurons that block the signal in the projection neurons that connect to the brain, and thereby blocking pain perception. If small nerve fibres become active and stimulate

Figure 1.1 The K-Laser™ programmed and ready to use on a patient.

the projection neurons, this blocks the inhibitory interneurons and pain will be perceived in the brain.

When the TENS machine is set at a frequency of 2–5 Hz this stimulates the body to produce its own pain-easing chemicals, endorphins, thereby blocking the pain signals.

Many research studies have investigated the positive effects of TENS in humans with orthopaedic and neurological conditions. One study (Millis & Levine, 2014) investigated the effect of TENS on osteoarthritic pain in the stifle of dogs. Five dogs with chronic mild

osteoarthritis, induced by cranial cruciate ligament resection and stifle stabilisation, were treated with TENS stimulation (70 Hz) applied to the affected stifle. Pre-treatment ground reaction forces were determined using a force plate before electrical stimulation to assess the functional use of the limb.

Significant improvements in ground reaction forces were found 30 minutes after treatment. These differences persisted for 210 minutes after TENS application and were statistically significant 30, 60, 120 and 180 minutes after treatment.

Each dog was re-evaluated following a 4-day rest period and still exhibited a mild increase in weight-bearing on the affected limb, but these differences were not significant. The author concluded this preliminary study showed positive benefits of TENS application in dogs with osteoarthritic stifle joints.

Manual techniques

Passive range of motion exercises

Passive range of motion (PROM) exercises are movements usually of the limbs performed by an individual such as a physiotherapist. The joints of the limbs are moved passively, and the patient does not gain any *strengthening* benefits from passive movements of the limbs.

PROM exercises are performed to maintain or improve joint ROM, and to prevent joint inflammation and stiffness. PROM exercises are especially important in recumbent animals that may already have established osteoarthritis and associated pain, stiffness and reduced ROM in the affected joints.

If the patient has undergone joint surgery full ROM of the joint is neither desirable nor essential in the early stages. However, full ROM should be maintained in all the other joints of the affected limb.

PROM exercises can commence from day 1 postoperatively. Gentle PROM exercises within the pain-free range will assist with lymphatic drainage of the limb and limit oedema when used in conjunction with positioning. If the distal limb is oedematous, compression followed by

release exercises can be performed: two sets of 50 repetitions appear to be effective.

As the inflammatory phase passes PROM exercise of the affected joint may be gradually increased within the pain-free range, and with consent from the veterinary surgeon.

The animal is usually recumbent for the PROM exercises with the affected limb(s) uppermost. (However, the exercises can be performed in standing with the patient supported.) If the animal has undergone joint surgery this joint should be isolated and gently moved through its pain-free range in all anatomical planes. This joint would then be supported and the other joints in the affected limb would be moved through full ROM in all anatomical planes. PROM exercise three sets of 10 repetitions for each joint twice a day is considered to be effective.

If the patient has not undergone joint surgery and the PROM exercises are being performed to reduce pain, inflammation and stiffness in the joint, all the joints in the limb can passively be moved together. Be aware that if the patient has established osteoarthritis, ROM in the joint may be reduced and at the end of range you will feel a *bony block*; *do not* force the joint beyond this point as it will cause the patient further discomfort.

When performing PROM exercises the movements of the operator will push the joints together and then push them apart. PROM exercises should *never* involve pulling a limb or joints. Do not grip the limb tightly. If all joints are to be moved together into flexion then extension the patient should be supported at the medial elbow for the thoracic limb, and at the medial stifle for the pelvic limb to prevent any rotation of the joints, which may be uncomfortable. The movements should be in line with normal anatomical planes of movement (Table 1.2).

Stretches

Stretches are performed to maintain or increase muscle length. These are usually performed passively by an operator for recumbent patients, or in patients that have undergone surgery.

Table 1.2 Normal canine joint range of motion.

Joint	Degrees of movement
Carpus	Flexion 20–35° Extension 190–200° Valgus 10–20° Varus 5–15°
Elbow	Flexion 20–40° Extension 160–170°
Shoulder	Flexion 20–40° Extension 160–170° Abduction 40–50° Adduction 40–50°
Tarsus	Flexion 40° Extension 170°
Stifle	Flexion 45° Extension 160–170°
Hip	Flexion 55° Extension 160–165°

If a muscle crosses two joints, such as the quadriceps, any shortening of this muscle group will affect the ROM of the hip and stifle joint. As the quadriceps muscle group shortens, the stifle and hip will be brought into flexion. If the quadriceps becomes shortened or contracted for a prolonged period of time the patient will be unable to extend the stifle and hip, and so weight-bearing through the limb will become problematic.

Changes in muscle length can occur quickly in: (i) recumbent animals; (ii) patients that have recently undergone surgery when they may not be moving limbs through their full ROM; or (iii) an animal that is non-weight-bearing for a period of time, when the flexor muscles will become short and tight, and the opposing extensor muscle groups will become weak.

In recumbent animals stretches should begin on day 1. Flexor, extensor and internal rotator muscle groups should be stretched at least twice daily. Each stretch is held for 15 seconds, the animal is given a few seconds to rest, then the stretch is repeated three times in total. Following stretches, if the patient is resting in lateral recumbency, a wedge should be placed between the thoracic and pelvic limbs to prevent adductor/abductor muscle imbalance. Recumbent animals tend to become tight in the adductor muscle groups, and weak in the abductor muscle groups. Correct positioning following stretches can help to prevent muscle imbalance from occurring.

Stretches can be performed with the patient lying laterally or in standing. If the stretches are performed in standing, the animal will need to be supported at the trunk. The operator will use one hand to support at the origin of the muscle being stretched; with other hand a pushing force will be applied at the insertion of the muscle. The muscle should be stretched until resistance is felt in the muscle, then at this point the stretch should be *held* for 15 seconds and repeated three times. Stretching should not be uncomfortable for the patient. As described earlier pre-warming a muscle will improve the elasticity of the tissues, thus improving the range of the stretch. This may be useful if the animal is cold, has muscle spasm or has developed muscle contractures.

Mobilisations

Mobilisations are graded movements or manipulations of joints that are passive and usually performed by a physiotherapist.

The grade of movement delivered depends on the desired effect of the mobilisation or manipulation. For example, a grade II mobilisation would be a repetitive movement of a joint within its pain-free range with the aim of relieving pain within the joint. However, a grade III mobilisation would also be a repetitive movement of a joint but greater force would be applied with the aim of increasing ROM within that joint.

Mobilisations are treatments used to maintain ROM in painful joints; once the pain within the joint is manageable the grade of mobilisation can be increased to increase ROM within stiff joints.

The operator will be positioned close to the patient. If, for example, the joint mobilisation is to be applied to the spinal processes of the lumbar spine to increase extension the patient will preferably be lying in sternal recumbency. The operator will position her or his hands so that one thumb overlaps the other and using a pulsing motion pressure will be applied directly to the spinal process. *The physiotherapist is aligned over the patient and the pressure transmits from the shoulders down the arms to the thumbs; if the pressure was generated from the thumbs alone the physiotherapist would fatigue quickly*.

In conjunction with passive exercises to improve ROM and passive stretches to increase muscle length, progressive exercise programmes focused around the assessment findings can be useful adjuncts to achieve short- and long-term goals.

Progressive exercise programmes

1 Begin with gentle passive and progressive PROM exercises; aim to work within the pain-free range. Repeat the PROM flexion/extension exercises for three sets of 10 repetitions.

Consider the use of electrotherapy such as a class IV K-Laser™, if available, to reduce pain and inflammation within the joint and control scar tissue, which may reduce ROM.

If available hydrotherapy using an underwater treadmill (UWT) would be an ideal active exercise for the patient to increase ROM of the joint. Use the buoyancy effect of the water and fill to the level of the patient's mid-trunk. Start with slow speeds and short duration with plenty of rest breaks, then increase speed and time as the patient progresses.

2 Stretch short/tight muscles into early resistance, and hold each stretch for 15 seconds, then allow the patient to relax and repeat the stretch, for a total of three stretches. As the patient progresses with his exercise programme he will be functionally stretching

muscles as he ambulates and increases weight-bearing through the limb. Controlled stair climbing with support or ascending gentle slopes will all functionally stretch muscles.

3 Gently start to gradually increase weight-bearing on the affected limb by using weaving exercises to encourage weight transfer onto the affected limb. Start with the cones wide apart; to progress the exercise over the 6-week period reduce the distance between the cones, increase the speed of the exercise (tempting the patient with a treat may help), and gradually towards the end of the 6-week period reduce the support given by the sling.

Hydrotherapy using a UWT can also be used to strengthen the extensor muscles as the patient places his limb in the stance phase and pushes through the limb and enters the swing phase. As the patient progresses a faster belt speed will encourage longer strides and greater activity in the extensor muscle groups.

4 Inflammation within the joint may affect conscious proprioception (CP). Stepping over cavaletti poles will challenge and improve CP as the patient will need to think about where he is placing his limb once he clears the pole. Start with the poles low and wide apart, progress by increasing the height and number of poles. Progress him further by altering the arrangement of poles (high, low, high, low).

Exercising him on different surfaces will improve his CP, as on a slightly uneven surface he will receive increased afferent feedback from his foot to his brain signalling how he should place his foot. Start by exercising him on flat, firm, non-slip surfaces and progress him to grass, bark chippings and sand, which will be the most challenging surface.

Practising functional activities in a controlled environment will boost the animal's confidence to carry out these activities in the home environment. If the animal has stairs to negotiate in the home or other places he visits this activity should be practiced under supervision.

Stair climbing is a functional activity that requires strength to ascend the stairs, and balance to descend the stairs (Figure 1.2).

Figure 1.2 A patient ascending stairs. Note the reciprocal gait pattern: the right thoracic limb is flexed to step up, and the left pelvic limb is extended to push off onto the step. The right pelvic limb is flexed to place the limb on the stair, and the left thoracic limb is extended as weight is being taken through this limb.

Another common functional activity that the animal may need to perform is getting in and out of the car. A ramp is recommended for medium to large dogs. If the animal has not used the ramp before he may be reluctant to use it. Always make sure the ramp is firmly secured to the car. Start by practising getting into the car first so he can gain confidence. Practice this several times before attempting using the ramp to exit the car. Like with stair practice he will feel most vulnerable on the descent. It may be useful to have an assistant at the opposite side of the ramp to yourself to give extra reassurance and to assist the patient should he lose his balance.

Early gait re-education is vital to prevent any secondary complications or compensatory postures from developing. If the animal is

holding the limb in extreme hip flexion most of the time he is at risk of developing muscle imbalance (tight in flexors vs weak in extensors). He is also at risk of developing severe muscle atrophy in the extensor muscle groups, and reduced joint ROM.

Another point to note is the extra pressure placed on the other limbs, mainly the other pelvic limb and the contralateral thoracic limb. The joints and muscles in these limbs will be placed under greater stress so function in these limbs should also be assessed and treated as necessary. Also the lumbar spine should be assessed in pelvic limb chronically lame animals for any signs of stiffness, and for pain in the associated muscles, which may develop muscle tension or *trigger points*.

Laser therapy can be useful in treating lumbar spine pain and inflammation associated with chronic pelvic limb lameness. Alternatively, or as an adjunct to laser therapy treatment, direct ischaemic pressure treatment can be used at the site of the trigger point. A *gradual* pressure equating to approximately 4 kg is applied until the trigger point or muscle spasm diminishes.

Lumbar spine pain and stiffness can be treated with mobilisations. Start gently with grade II for pain relief, then progress to grade III to improve mobility and reduce stiffness.

Active-assisted (using a sling) exercises in a controlled environment are an excellent way to reduce gait abnormalities. As the patient is challenged by the exercises (weaving cones/cavaletti poles) he will not be able to compensate by mobilising on three limbs and therefore will commence with gentle weight-bearing, which is desirable at this stage of the rehabilitation programme.

5 Hydrotherapy using a UWT is another excellent exercise to improve gait abnormalities as the buoyancy of the water means the patient will have less weight and concussive forces passing through his joints so he will be more likely to use the limb. The warmth of the water will also assist in relaxing any muscle tension. The speed, duration (time), and level of the water (buoyancy effect) can all be

controlled to suit the needs of the patient and the rehabilitation programme. Start with slow speeds and short duration; it is important that the patient gains confidence to begin with.

The aim of the late-stage rehabilitation programme is to *fine tune* any minor discrepancies regarding joint ROM or muscle imbalances. The late-stage programme aims to improve strength of the affected limb, improve muscle bulk, improve CP and balance, and finally to improve stamina.

1 *Balance*: simply start by testing the patient's ability to resist perpetrations or 'nudges', forcing the patient to take weight through the affected limb(s). This exercise can be progressed to incorporate limb lifting. Start by lifting the affected limb, then progress to lifting the non-affected pelvic limb (support the patient as necessary with an arm under his abdomen at the start). Progress the exercise by lifting the contralateral thoracic limb (diagonal lifting). Hold each limb lift for 5 seconds and repeat five times.

   A wobble cushion can be placed under the patient's limb. Perpetrations or nudges at the contralateral hip will force the patient's limb onto the wobble cushion, which is an unstable surface so he will need to use stabilising muscles in the limb to maintain his balance. If this exercise is well tolerated, it can be progressed by incorporating limb lifting of the contralateral pelvic limb whilst the affected limb is balancing on the cushion. This will increase the stabilising muscle strength in the limb and also further challenge his ability to balance. Hold each limb lift for 5 seconds and repeat five times.

   Wobble boards can also be used to challenge balance and improve strength. The patient walks onto the board and faces forwards. Start by gently wobbling the board in an anterior/posterior motion. If the patient tolerates this progress to challenge the patient's balance in the medial/lateral motion. Progress this exercise further to target a limb by incorporating limb lifting into the exercise; start by lifting a pelvic limb. This will force the patient to take more weight through the standing limb, thus increasing strength, and challenging balance.

Because a dog takes 60% of his bodyweight through his thoracic limbs this exercise can be further progressed again by lifting the contralateral thoracic limb (diagonal limb lifting), forcing the patient to shift his weight back onto the pelvic limb to increase strength and balance. Hold each limb lift for 5 seconds and repeat five times.

The owner can be taught how to carry out the limb-lifting exercises at home. The owner could also have the patient walk in figures-of-eight or in circles to challenge balance. Start with wide figures-of-eight and circles, and then progress by making them smaller.

2 *Stamina and cardiovascular* (*CV*) *fitness*: will start to improve as the patient is allowed more lead exercise at this stage. Hydrotherapy can be useful in the late stages of rehabilitation as the speed of the belt can be increased to a fast walking pace or gentle trot; this will also improve joint ROM as the patient will take longer strides and improve extensor muscle strength as he propels himself forwards. The level of the water can also be adjusted to give a strengthening effect. The greatest resistance of the water is at the surface level so this level should correspond with the level of the muscle groups you are aiming to strengthen. Resistance can be added by using the UWT water jets; this will further increase strengthening. The work time can also be increased, and the rest time decreased to increase stamina and CV fitness.

Musculoskeletal presenting conditions

The coxofemoral joint

Common conditions associated with the coxofemoral joint, or hip joint as it is often referred to, include:

- Hip dysplasia.
- Legg–Calvé–Perthes disease.
- Fractures.
- Luxations.

The coxofemoral joint is stabilised by the:

- Teres ligament.
- Joint capsule.
- Dorsal acetabular rim.
- Surrounding muscles.

Hip dysplasia (HD)

Hip dysplasia is described as an abnormal development of the coxofemoral joint characterised by subluxation or complete luxation of the femoral head from the acetabulum in young animals (<1 year old) leading to degenerative joint disease in later life.

HD is thought to be a multifactorial disease process. The *primary* cause is thought to be hereditary, and the incidence of HD is highest in large breeds of dogs including Labradors and German shepherd dogs. *Environmental* factors cited include rapid weight gain, rapid growth and over-exercise.

Hip dysplasia is also seen in humans. However, this is not considered a hereditary condition and is not screened for. The primary cause in humans relates to the size (large) and presentation of the foetus. The incidence is highest in large female babies who develop in a confined space with the hip joint flexed and rotated. All babies are assessed for excessive hip laxity shortly after birth. If hip dysplasia is confirmed the baby is fitted with a special hip brace, which is worn for most of the day for a period of months to correct the hip deformity.

However, the disease process of HD in animals is described as:

- Slackening of coxofemoral joint ligaments.
- Subluxation of the femoral head from the acetabulum.
- Destruction of cartilage surfaces.
- A change in shape of joint surface, the femoral head becomes flattened, and the acetabulum becomes shallow.

Secondary osteoarthritis develops resulting in new bone growth at the destroyed cartilage sites, and the formation of fibrous tissue within the joint space as an attempt to provide joint stability.

History

1 Joint instability/wobbly pelvic limb gait pattern.
2 Pain, especially on end-of-range hip extension, and later abduction.
3 Muscle atrophy, especially in gluteals.
4 Difficulty rising, especially after lying for a long period of time, which is common in the morning, or following exercise.
5 Exercise intolerance or reduced levels of exercise.

Physical examination

1 Increased hip laxity caused by weakened ligaments and sub/luxation of the hip joint.
2 Reduced ROM in the hip joint, caused by remodelling of the joint surfaces and associated joint fibrosis.
3 Poor musculature; the animal will be reluctant to weight-bear through the affected limb and will attempt to shift weight onto other limbs, often most evident in stance.

Hip dysplasia – general management

Dietary management: control weight gain especially in immature animals that are still growing. Immature joints have a higher degree of mobility; increased weight gain will place further stress on these developing joints.

Exercise management: again in immature animals that are still growing excessive uncontrolled exercise can place the developing hip joint under increased stress, which may lead to an abnormally developing joint.

Pain control: short-term use of 1–3 weeks' analgesia and strict rest may be prescribed by a veterinary surgeon if indicated.

Nutraceuticals: these may be considered as an adjunct to therapy. The aim of these natural products is to protect the cartilage surfaces

and prevent the formation of new bone forming at these sites. Since the changes in cartilage occur early in the disease process the use of nutraceuticals should commence at an early stage also.

Chondroprotectants and nutraceuticals are compounds that are proposed to have a positive effect on the health and metabolism of chondrocytes and synoviocytes (Beal, 2004).

Chondroprotective agents have three main effects:

1 To support or enhance metabolism of chondrocytes and synoviocytes (anabolic).
2 To inhibit degradative enzymes in the synovial fluid and cartilage matrix (catabolic).
3 To inhibit formation of thrombi in the small blood vessels supplying the joint (antithrombotic) (Beal, 2004).

A combination of glucosamine hydrochloride, chondroitin sulphate, manganese and ascorbate is a commonly used nutraceutical in osteoarthritic small animals (Hulse, 1998). The use of these nutritional supplements is supported by clinical studies investigating the treatment of osteoarthritis (Leeb et al., 2000).

Cosequin® has also been found to suppress the anti-inflammatory effects of acute synovitis and immune-mediated arthritis (Beren et al., 2001; Canapp et al., 1999).

Hip dysplasia – conservative versus invasive surgery

The surgical options for hip dysplasia include total hip replacement (THR) or femoral head and neck excision (FHNE) (Figure 1.3). However, when choosing between conservative therapy and surgery, one should take into account the animal's age and current level of activity. The aim of the rehabilitation programme should be to return the animal to its highest level of function. A case study of a conservative rehabilitation programme illustrates a typical approach taken with a 12-month-old dog.

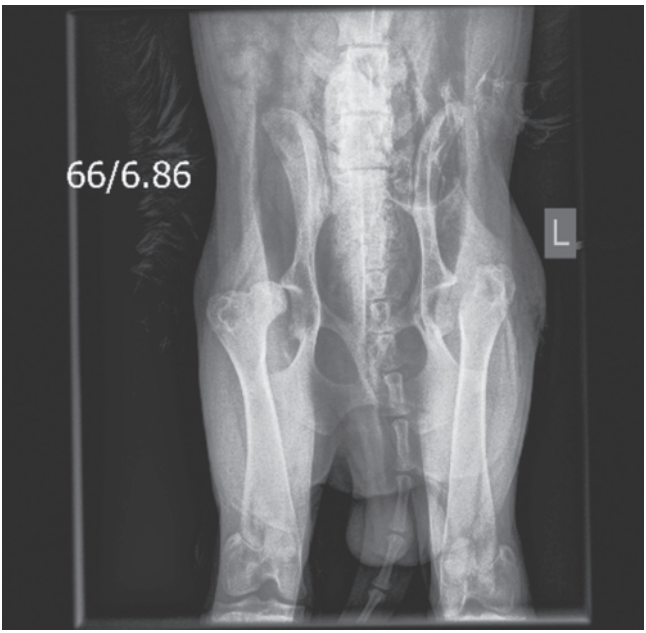

Figure 1.3 Severe hip dysplasia with a left femoral head and neck excision.

CASE STUDY: A PHYSIOTHERAPY REHABILITATION PROGRAMME (CONSERVATIVE) FOR HIP DYSPLASIA

Introduction

'Harvey' is a 12-month-old, male, entire Labrador retriever.

Presenting condition (*PC*): He presented to the referring veterinary surgeon because he was stiff to rise, but the stiffness eased relatively quickly when the dog walked around for a few minutes.

Past medical history (*PMH*): Nil of note. Harvey is up to date with routine vaccinations and worming. His body weight is optimal.

Drug history (*DH*): A 10-day course of a non-steroidal anti-inflammatory drug (NSAID) was prescribed by the veterinary surgeon to treat his flare-up of pain, and he is on glucosamine and chondroitin supplement long term.

Social history (*SH*): Harvey enjoys walks and chasing balls. He has four walks a day, two longer off-lead walks of one hour duration, playing with other dogs and chasing balls. Two shorter lead walks of approximately 10 minutes. He has free access to a garden. He has stairs in the house but doesn't need to go upstairs. He does not live with any other animals.

Referral details: The referring veterinary surgeon diagnosed Harvey with hip dysplasia; the right pelvic limb was found to be more affected than the left pelvic limb.

Physiotherapy assessment

- *Gait*: 2/5 lame right pelvic limb, with reduced hip extension and slight hip internal rotation.
- *Posture*: Shifts weight from right pelvic limb to left pelvic limb in stance.
- *PROM*: Reduced hip extension and abduction, right more affected than left pelvic limb. Pain is evident on passive hip extension, at end of range.
- *Muscle mass*: Reduced bulk especially hamstrings and gluteals; right more affected than left pelvic limb; right pelvic limb 32 cm, left pelvic limb 34 cm.
- *Muscle length*: Slightly tight hamstrings bilateral.
- *Static weight-bearing percent on pelvic limbs*: Right pelvic limb 42%, left pelvic limb 58%.
- *Pain score*: 2/4 on manipulation of coxofemoral joint.

Problem list

1 Coxofemoral joint pain.
2 Reduced coxofemoral joint ROM (hip extension).
3 Reduced muscle length (hamstrings).
4 Reduced muscle mass right pelvic limb.
5 Altered gait pattern with reduced pelvic limb function.

Goals

1 Reduce pain (2–6 weeks).
2 Improve hip joint ROM (6 weeks).

3 Improve muscle length (6 weeks).
4 Improve muscle mass and strength (6–12 weeks).
5 Gait re-education (6–12 weeks).

Treatment

Therapeutic laser

Apply bilateral laser treatment to the hips, to reduce pain; the power and time (duration) of treatment will depend on the patient's skin colour, bodyweight and stage of condition (acute or chronic).

PROM exercises

To maintain joint ROM at the hip, stifle and tarsus joints. All joints are flexed, and then extended. Rotation of the limb is avoided, with one hand supporting at the medial stifle joint. Note that the limb is not gripped and no pulling of the limb occurs; the distal hand pushes the limb into flexion, then the proximal hand, which is medial and anterior to the stifle joint, pushes the limb into extension.

Three sets of 10 PROM repetitions are performed on each pelvic limb; there is no hold at the end of full flexion or extension so one repetition of pelvic limb PROM should not take more than one to two seconds. Three sets of 10 repetitions should be completed in 30–60 seconds if the patient is compliant.

Passive stretches

Hip flexors, hamstrings and adductors are stretched passively. Again avoid any rotation of the joints of the pelvic limb and support the distal limb. Each stretch should be taken into resistance and held for 15 seconds and repeated three times. Stretching should not be painful for the patient. If the patient is very tense gentle warm-up exercises may assist with stretching, or warming the muscles with heat packs pre-stretching may be beneficial. With hip dysplasia, extension and abduction are usually the most uncomfortable movements for the patient, so be aware that full hip extension and abduction may not be possible if the patient has developed secondary osteoarthritic changes around the hip joint.

Active exercises

Weaving cones – begin by placing the cones approximately the length of the dog's body apart. As he progresses the distance between the cones

can be narrowed and more cones may be added. Weaving exercises will encourage the patient to transfer weight onto the affected limb, and will also strengthen adductor and abductor muscles around the hip joint.

Cavaletti poles – aim to place the poles to correspond with the dog's normal stride length to begin with. Start with the poles positioned at an achievable height. As the patient progresses the arrangement of poles can be adjusted to increase limb flexion and joint ROM.

Stairs – are a functional activity and challenge strength and ROM in the pelvic limbs as the patient pushes off to ascend the stair. Balance and weight-bearing through the thoracic limbs are challenged as the patient descends the stairs. Bunnyhopping up the stairs may be seen in animals with reduced ROM or strength in the pelvic limbs; however, bunnyhopping on stairs may be *normal* for small dogs.

Wobble board – this equipment should be introduced gradually to ensure patient compliance. With the patient positioned with all four limbs on the board passively rock the board left and right to challenge the patient's right or left side limbs. Alternatively the patient may be positioned to challenge thoracic or pelvic limbs by rocking the board forwards and backwards. This exercise will improve stability around the hip joint; as the patient resists the movement of the board his stabilising and postural muscles will be activated.

Underwater treadmill (*UWT*) – begin with short-duration sessions and use the buoyancy effect of the water to reduce the load and concussive forces passing through the joints of the limbs. If the patient has severe osteoarthritis secondary to hip dysplasia he will find exercising in the UWT comfortable. The temperature of the water, level of the water and speed of the treadmill belt can all be controlled.

Progression

Wobble board: This exercise can be progressed by incorporating limb lifting (Figure 1.4).

UWT: Increasing the duration of exercising in the treadmill will improve stamina. Increasing the speed of the belt will improve joint ROM and stride length. The water level can be lowered to reduce the buoyancy effect of the water and improve strengthening. Further strengthening can be achieved by using resistance from the water jets.

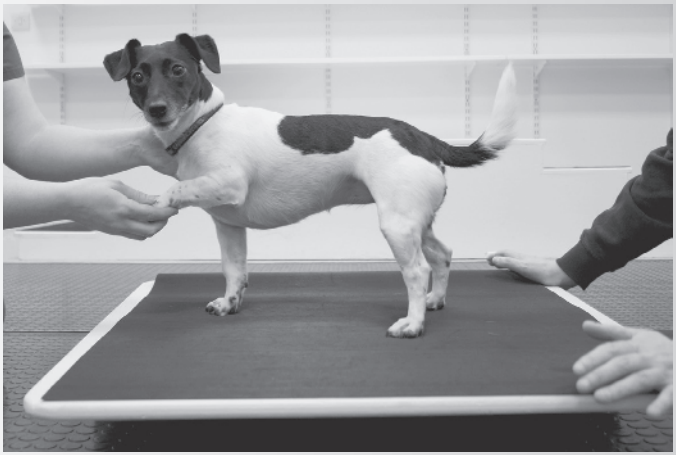

Figure 1.4 A patient balancing on a wobble board. The left thoracic limb is lifted to target strengthening and stability in the right thoracic limb.

Evaluation

It is important to evaluate treatment to ensure it is effective. Once a patient has achieved his short-term goals progress him on to improve joint ROM and muscle length in the mid-phase rehabilitation programme, then finally in the late phase of rehabilitation progress him again to improve strength and muscle mass, to rehabilitate him back to his highest level of function.

Outcome measures

Baseline measures should be taken at the time of the first assessment. Assuming the patient is attending on a weekly basis re-measure outcomes at 6 and 12 weeks.

Joint ROM – of the coxofemoral joint using a goniometer should be taken at the initial assessment. Measure and record passive hip extension, abduction and flexion.

Muscle mass – can be measured using a tape measure. Aim to measure around the muscle belly of the hamstrings/quadriceps; this will approximately be at the level of the mid-femur. As the patient begins to build muscle mass

and strength this will show with a increase in muscle circumference. It is good practice to take three measures, and then use the average from these readings as the final measure.

Gait – video the patient's gait pattern at the initial assessment. This can then be compared to later videos to demonstrate positive changes in gait pattern. The lameness score can also be assessed from the videos.

Function – measure weight-bearing through the affected limb and the contralateral limb for comparison of limb function at the time of assessment it will be a useful measurement to re-test as the animal progresses. Normal bathroom weighing scales have been shown to be a valid measuring tool to assess weight-bearing in dogs.

Pain – subjectively the owner may provide feedback such as the dog's ability to walk further, or a willingness to play with other dogs and toys without any signs of increased lameness or difficulty rising. The owner may also feedback a decrease in the patient's analgesic requirement. Pain score measures should be repeated at 6 and 12 weeks and compared with baseline to evaluate the effectiveness of treatment.

Stifle joint

The canine stifle is made up of bones that form joints, which are supported by ligaments and menisci.

Anatomy

Bones

- Femur.
- Tibia.
- Patella.
- Fabellae.
- Popliteal sesamoid.

Joints

- Femoral-tibial.
- Patella-femoral.

Ligaments

- Cranial cruciate ligament – stabilises the tibia relative to the femur to prevent hyperextension and also internal rotation of the tibia.
- Caudal cruciate ligament – stabilises the tibia to prevent caudal displacement relative to the femur.
- Medial and lateral collateral ligaments – prevent valgus and varus movement of the stifle joint.

Menisci

- Medial.
- Lateral.

Cruciate ligament injury

Cruciate injury is a relatively common condition in small animals. It is typically seen in young active dogs. Presentation maybe seen as an acute, chronic or a partial tear.

Aetiology

Canine cruciate ligament (CCL) rupture may be acute and related to trauma, and seen in any breed. Chronic injury occurs over a period of time and may be multifactorial in nature. Obesity and muscle imbalances may contribute to chronic cruciate injury. Partial tears can cause pain and inflammation; if the tear is minor it may settle with rest and conservative treatment. However, major partial tears may require a more invasive approach (surgery) (Figure 1.5).

It may be worth noting that not all humans or indeed animals undergo surgical procedures to stabilise a ruptured cruciate ligament. Over time capsular fibrosis occurs and this scar tissue stabilises the joint to some degree. However, a trade-off may be some loss of ROM in the stifle, but the limb will be functional. If the patient goes on to develop a meniscal injury this will require surgical intervention as

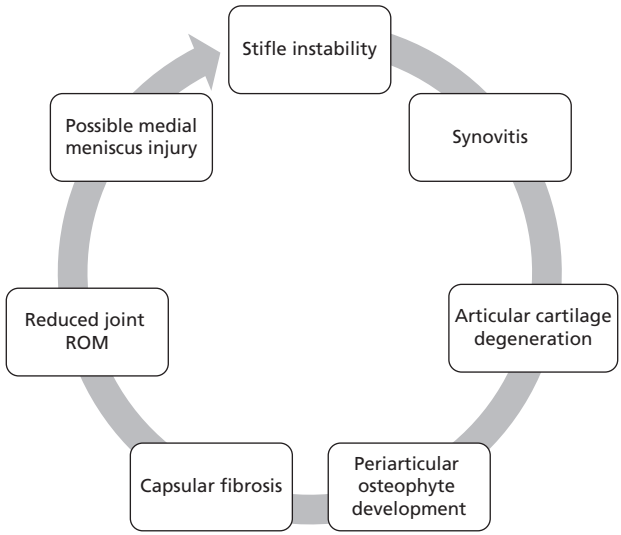

Figure 1.5 Sequence of cranial cruciate ligament disease events.

pain will be present when the animal flexes and loads the joint, resulting in chronic lameness. Secondary osteoarthritis of the stifle joint will occur as a consequence of CCL injury.

Clinical signs

- Lameness – non-weight bearing if acute, subtle lameness associated with exercise in early partial tears.
- Joint effusion – seen in the acute stage, and is part of the normal injury inflammatory process.
- Fibrosis – (medial buttress), palpate medial aspect of stifle joint and compare with the contralateral stifle.

- Muscle atrophy – (indicates its not an acute injury).
- Decreased ROM of the affected stifle.
- Crepitus or meniscal clicking of the stifle during passive flexion and extension may be evident.

Conservative treatment

- Rest.
- Non-steroidal anti-inflammatory drugs (NSAIDs) for 6 weeks.
- Weight reduction (if appropriate).
- Controlled exercise to strengthen the hamstring muscle group to stabilise the tibia and prevent *forward draw* of the tibia.

Surgical treatment

Extracapsular:

- Lateral fabellar suture.

Intracapsular:

- Over-the-top technique (OTT).
- Tibial plateau levelling osteotomy (TPLO).
- Tibial tuberosity advancement (TTA).
- Tibial wedge osteotomy (TWO).
- Triple tibial osteotomy (TTO).

Tibial osteotomies all aim to eliminate cranial tibial thrust, and provide long-term stability of the stifle joint. Long-term studies are required to provide evidence of each technique's effectiveness.

Complications

- Infection.
- Implant failure.
- Late meniscal injury.
- Persistent lameness.
- Osteoarthritis.
- Rupture of contralateral cruciate ligament.

CASE STUDY: A PHYSIOTHERAPY REHABILITATION PROGRAMME FOR CANINE CRUCIATE LIGAMENT RUPTURE (CONSERVATIVE)

History

Buster is a 12-year-old neutered Labrador. He has a right stifle cranial cruciate ligament rupture and is being referred for physiotherapy. He is overweight at 40 kg, and is currently on a calorie-restricted diet.

Assessment

1 Right stifle pain on manipulation 2/4 (0–4 scale).
2 PROM: resents end-of-range flexion and extension of right stifle, mild joint effusion and thickening of stifle joint medially. (Right flexion 40°, right extension 155°; left flexion 45°, left extension 160°).
3 Muscle length: tight right hamstrings.
4 Muscle mass: reduced global bulk right pelvic limb (right circumference 26 cm, left 29 cm).
5 Weight-bearing: shifts weight in stance onto contralateral pelvic limb (right 40%, left 60%).
6 Gait: toe touching lame right pelvic limb (videoed).

Problem list

1 Right stifle pain.
2 Reduced ROM right stifle.
3 Reduced muscle length right hamstrings.
4 Reduced muscle mass right pelvic limb.
5 Reduced right pelvic limb function.
6 Abnormal gait pattern.

Goals

1 Reduce pain (2–6 weeks).
2 Improve right stifle ROM (6 weeks).
3 Improve hamstring length right pelvic limb (6 weeks).
4 Improve strength right pelvic limb (6–12 weeks).
5 Improve right pelvic limb weight-bearing (6–12 weeks).
6 Gait re-education (6–12 weeks).

Passive exercises

PROM: An exercise to maintain joint ROM; three sets of 10 repetitions are recommended. The three major joints in the pelvic limb are flexed together and then extended; take care to avoid any rotation of the joints especially the stifle. With the patient lying in left lateral recumbency use one hand to support the stifle joint medially; the other hand is placed below the calcaneus and pushes all the joints into flexion; the first hand will push from the distal femur to bring the joints into extension. *N.B. No pulling or harsh gripping of the tissues occurs. Do not force full stifle flexion/extension in the early stage.*

Stretches: Gentle progressive stretches of hamstring muscle groups; three stretches into resistance held for 15 seconds is recommended. If the patient has been lame for some time the hip flexor muscle group may also be tight: three stretches into resistance held for 15 seconds is recommended. *N.B. Stretching should not be painful for the animal, but ensure the stretch is into resistance to obtain effective treatment – the aim of the stretches is to increase muscle length.*

Laser therapy: To reduce pain and inflammation of the stifle joint.

Active exercises

Weaving cones: To encourage weight transfer onto the affected limb, and to encourage abduction and adduction of the affected limb (Video 1.1).

Cavaletti poles: Will encourage flexion of the stifle joint and improve proprioception as the patient will think about where he is placing the limb with the visual prompt of the poles, when he places the limb (Video 1.2).

Stairs: This is a functional activity and so should be practised in a controlled environment. The patient will require strength in the pelvic limbs to ascend the stairs; balance and proprioception will be challenged as the patient descends the stairs; keep in close to the patient so that if he loses balance on the stairs you will be able to support him.

VIDEO 1.1

Weaving cones. The video shows a patient being led through weaving cones to encourage limb weight transfer and abduction and adduction of the limbs. This active exercise also encourages lateral spinal flexion.

VIDEO 1.2

Cavalleti poles. The video shows a patient being led over equally spaced cavaletti poles. This active exercise improves joint ROM as the patient flexes his limbs to clear the pole. As the patient progresses the height of the poles can be increased. This exercise also challenges and therefore improves proprioception because the patient will use the visual prompt of the poles to think about how high he will need to flex his limb and also where he will place his limb. This exercise can be progressed by increasing the height of the poles, or arranging the poles alternately high then low.

Wobble cushions: This exercise is used to strengthen the muscles to stabilise the affected limb; it will also challenge and therefore improve balance. Place the wobble cushion under the affected limb and nudge the patient at the contralateral limb so that he is taking weight on an unstable surface through the affected limb(Figure 1.6). Progress this exercise by incorporating limb lifting of the unaffected pelvic limb while the patient is weight-bearing through the affected limb on the wobble cushion (Figure 1.7). Hold the unaffected limb for 5 seconds; let the patient rest then repeat for a total of five repetitions. *N.B. Support the patient under the abdomen with your arm as necessary until he builds confidence and strength with this exercise.*

Wobble board: Once the patient has mastered the wobble cushion progress to the wobble board; keep the session time on the wobble board short to begin with until the patient becomes accustomed to the exercise. The patient stands with all four limbs on the wobble board. By passively rocking the board forwards the patient will be taking weight through the thoracic limbs, and when rocked backwards the patient will be taking weight through the pelvic limbs. If the patient changes direction the left and right side limbs can be challenged. This exercise will improve strength and stability in the limbs, and improve general core strength and stability. The exercise can be progressed by incorporating limb lifting; lifting the unaffected pelvic limb will strengthen and stabilise the affected pelvic limb. To further change the patient progress by lifting the contralateral thoracic limb.

N.B. Support the patient under the abdomen with your arm as necessary until he builds confidence and strength with this exercise.

Figure 1.6 A patient's left thoracic limb on the wobble cushion, with the right thoracic limb lifted. This unstable surface will challenge and improve conscious proprioception in the left thoracic limb. This exercise also has a strengthening/stabilising effect on the limb.

Figure 1.7 A patient weight-bearing and balancing on a wobble cushion. The left pelvic limb is lifted to further strengthen and stabilise the right pelvic limb.

Hydrotherapy: Walking in an UWT will increase limb ROM, and improve functional ability as the warmth of the water and buoyancy effect will provide the patient with a comfortable environment to exercise in with reduced concussive forces passing through the limbs. Begin with short sessions and provide plenty of rest breaks. Initially, set the treadmill belt slower than the patient's normal gait speed to ensure he is using the limb functionally and weight-bearing through the affected limb.

As the patient progresses use the water to provide strengthening rather than buoyancy so the patient has to push through the water to build muscle strength. The surface level of the water is where most resistance is found so set the water level to mid-femur to improve muscle strengthening. Increasing the speed of the treadmill belt will encourage the patient to take longer strides, which will increase ROM and encourage extensor muscle activity and therefore strength. Using water jets to provide resistance will also further strengthen the patient. Increasing the exercise time and reducing the rest time will improve cardiovascular fitness and stamina.

Rehabilitation following surgical repair of cranial cruciate ligament rupture

CCL rupture treated by surgical repair would tend to follow a similar rehabilitation programme (Figures 1.8 and 1.9). Ensure you are familiar with the type of CCL repair the patient has undergone – that is, extracapsular lateral suture repair or open reduction internal fixation (ORIF) osteotomy stabilisation. Generally a patient would be referred following suture removal and a satisfactory check-up by the veterinary surgeon. (Alternatively the surgeon may wait until 6 weeks postoperatively to refer the patient for physiotherapy.)

In the early phase (0–2 weeks postoperatively) focus on gentle ROM exercises to maintain joint ROM. Stretches of the hip flexors, hamstrings and adductors will maintain muscle length. Laser therapy can be used to reduce pain and inflammation, as indicated. The patient may be toe touch or PWB; use *The Soft Quick Lift*™ sling

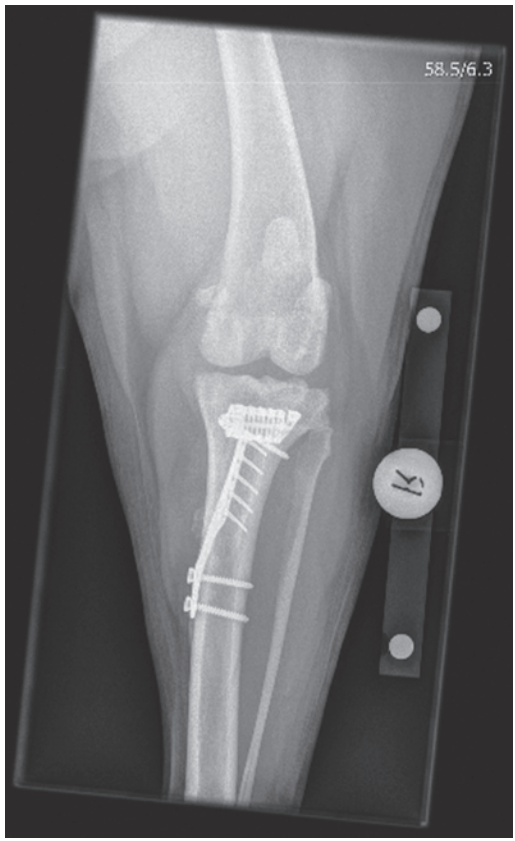

Figure 1.8 A right cranio-caudal postoperative tibial tuberosity advancement.

to support the patient and to assist him with balance. Short, gentle, controlled lead exercise with sling support for 5 minutes four times daily is recommended in the early phase. When using a sling support the owner should take up a position at the hip on the same side as the

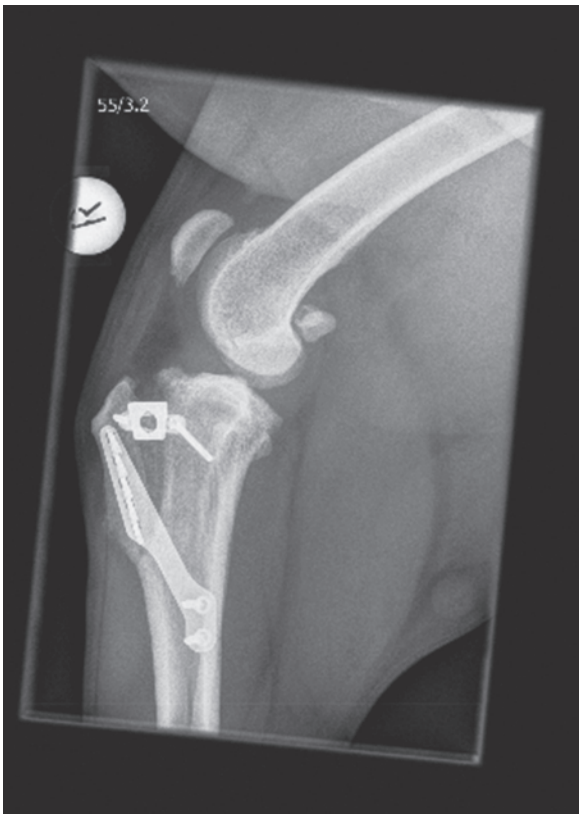

Figure 1.9 A right lateral postoperative tibial tuberosity advancement.

unaffected limb so they can gently transfer the patient's bodyweight onto the unaffected limb, but whilst taking some bodyweight so as not to overload the unaffected limb.

In the mid-phase (2–6 weeks postoperatively), continue with the PROM exercises, stretches and laser therapy from the early phase,

and begin to introduce active assisted exercises (active assisted exercises incorporate the use of a sling to prevent the patient from losing balance, and also to prevent him taking excessive weight through the affected limb). Weaving exercises, cavaletti pole work and hydrotherapy using a UWT to encourage functional use of the limb can all begin at this stage. The patient will not require the use of a sling in hydrotherapy because the buoyancy of the water will support the patient's balance and reduce bodyweight and concussive forces passing through the limbs. However, a member of staff should also be in the water with the patient for safety and reassurance should he panic, and to support him with the sling into and out of the water treadmill.

In the late phase (6–12 weeks) the patient should have regained full ROM of the joint and normal muscle length. He should also have started to increase weight-bearing through the limb and therefore have improved strength and function in the limb. He may now only be dependent on the sling when his strength, balance and proprioception are challenged, such as on stairs, which can be introduced to the patient at this stage in a controlled environment. The number of weaving cones and height of cavaletti poles can also be increased at this stage.

Towards the end of the late phase introduce balance changes with wobble cushions, progress balance, and improve limb stability and strength by incorporating limb lifting into the exercise. This exercise can be progressed by introducing the wobble board, which challenges balance in all limbs, and in four planes of movement. The wobble board also improves core stability, limb strength and stability.

Hydrotherapy using a UWT is a functional way for the patient to increase ROM, strength and improve CV fitness. The water can be used to provide resistance and further resistance can be added by using water jets. The speed of the belt can be increased to encourage longer strides to improve ROM of the joints; rest breaks can be reduced and time spent exercising in the UWT increased to improve CV fitness.

Following a satisfactory 12-week check from the veterinary surgeon the owner can commence with short periods of off-lead exercise in an enclosed space.

Evaluation of rehabilitation

Aim to evaluate the patient's progress at regular intervals. Measure baseline data at assessment, and re-measure at 6 and 12 weeks to evaluate the effectiveness of treatment, and to guide progression of the rehabilitation programme.

- Assess and score pain on manipulation of the limb, and from the owner's feedback.
- Measure joint ROM using a goniometer.
- Measure the circumference of muscle mass around the muscle belly; compare with the contralateral limb measures.
- Measure weight-bearing through the limb using bathroom scales, or a pressure-sensitive mat.
- Video gait pattern, and score lameness (0–5 scale).

Obtaining optimal hamstring length and strength is important; the hamstring muscle group is made up of:

- Biceps femoris.
- Semitendinosus.
- Semimembranosus.

This group of muscles insert on the tibia, and have an important role in stabilising the tibia and preventing the characteristic *forward-draw* of the tibia over the femur seen in patients with deficient cranial cruciate ligament function.

The reason the hamstrings become weak is related to reduced weight-bearing on the affected limb. Progressive stretches of the hamstring muscle group will maintain optimal muscle length.

Scar tissue will form around the affected stifle joint. This is the body's natural way of stabilising the joint. Excessive scar tissue and thickened of the joint capsule will lead to reduced ROM at this joint. Secondary osteoarthritis will also lead to reduced joint ROM, and

pain. Excessive scar tissue may be reduced by laser therapy and PROM exercises to maintain functional ROM of the affected joint.

Meniscal tears are a relatively common finding associated with cruciate disease, and will often require surgical intervention. The medial meniscus is most often affected as relatively more weight passes through the medial meniscus when the animal ambulates.

Bilateral cruciate disease may also become evident. This may be related to the extra strain placed on the contralateral pelvic limb.

The patient may also develop changes in the lumbar spine related to abnormal gait pattern and uneven loading through the limbs. This may be seen as muscle tension over the lumbar spine with associated trigger points and lumber spine stiffness on palpation.

Patella luxation

The patella is a sesamoid bone located within the patella ligament. Luxation occurs when the patella rides outside the femoral groove when the stifle is flexed. It can be classified as medial or lateral; medial luxation is most common.

Each time the patella luxates the associated cartilage is at risk of damage, resulting in inflammation and leading to secondary osteoarthritis and pain.

Aetiology

- It can be traumatic (rare).
- It often relates to a shallow femoral groove.
- Muscle imbalance and poor limb alignment may result in patella luxation.
- Or it may be multifactorial in nature.

Incidence

- Often found in small dogs (poodle, Yorkshire terrier, Chihuahua).
- Presentation may be bilateral.

Clinical signs

- Lameness – intermittent or continuous.
- Pain – most evident in acute luxation.
- Bilateral medial patella luxations may have a *bow-legged* conformation.
- Bilateral patella luxations may have a *knock-kneed* conformation.

Diagnosis

- Palpation of the stifle.
- Plain radiographs.
- Computed tomography (CT).

Surgical treatment

Surgical correction involves reconstruction of the soft tissues associated with the patella and deepening of the femoral groove to correct tracking of the patella tendon (Table 1.3). If the luxation is medial the groove can be deepened on the lateral side.

Transposing the tibial crest may be performed to realign the quadriceps and the patella tendon.

The surgery is more challenging if the luxating patella is associated with angulation of the long bones.

Table 1.3 Patella luxation grades.

Grade	Description
I	Patella can be manipulated out of groove, but spontaneously returns to its normal position
II	Patella occasionally moves out of the groove, but can easily be manipulated back in to place
III	Patella moves out of the groove frequently, but can be manipulated back in to place
IV	Patella moves out of the groove persistently and cannot be replaced

Complications

- Reluxation.
- Infection.
- Implant failure.
- Persistent lameness.
- Osteoarthritis.
- Contra-lateral limb affected.

CASE STUDY: PHYSIOTHERAPY REHABILITATION PROGRAMME FOR A LUXATING PATELLA (SURGICAL)

History

Molly is a 2-year-old, female Maltese terrier. She has been referred for physiotherapy following surgery 6 weeks ago to treat a left pelvic limb (PL) luxating patella.

Physiotherapy assessment

- *Gait:* ambulatory, reduced weight-bearing through the left PL, and a reduced stance phase.
- *Lameness score:* intermittently carries limb, lame in trot, score 4/5 (0–5 scale).
- *Posture:* shifts weight from left to right PL in stance.
- *Pain score:* signs of moderate pain during palpation 2/4 (0–4 scale).
- *Joint ROM:* resents left stifle end-of-range (EoR) flexion/extension.
- *Muscle length:* tight in hip flexors, weak in hamstrings.
- *Muscle mass:* reduced bulk left PL; 1.5 cm difference compared to right PL.
- *Secondary complications:* nil obvious at this stage.

Problem list

1 Altered gait pattern.
2 Pain.
3 Reduced joint ROM.
4 Muscle imbalance.
5 Reduced strength/muscle mass.

Goals

1 Gait re-education.
2 Reduce pain.
3 Improve joint ROM.
4 Improve muscle imbalance.
5 Improve strength/muscle mass.

Physiotherapy out patient treatment plan

Early phase (0–2 weeks)

- Control pain and reduce swelling using cold therapy, or laser.
- Improve stifle and patella femoral joint ROM, using gentle PROM exercises.
- Short controlled lead walking 4 × 5 minutes a day.

Mid-phase (2–6 weeks)

- Continue laser therapy for pain control, and to control scar tissue.
- Continue PROM exercises and stretches.
- Begin proprioceptive exercises using cavaletti poles.
- Use weaving cones to encourage weight transfer onto the affected limb.
- Begin strengthening exercises using the UWT.
- Increase lead walks to 4 × 10 minutes a day.

Late phase (6–12 weeks)

- Continue laser, PROM exercises, begin soft tissue release techniques (STR), to ensure smooth patella mobility.
- Continue with cavaletti pole and weaving cone work.
- Challenge balance and proprioception using a wobble cushion and incorporate limb lifting to improve strength and stability.
- Introduce stair work, encourage the owner to introduce gentle gradients into the patient's lead walks, which should increase to 4 × 15 minutes a day.
- Progress hydrotherapy by increasing the time the patient spends working in the treadmill and reduce the water level to reduce buoyancy so the water is used to provide resistance.

Evaluation

Outcome baseline measures obtained at initial assessment should be repeated at 6 and 12 weeks to evaluate the rehabilitation programme and to guide progression.

Progression

Following a satisfactory check with the veterinary surgeon introduce work on the wobble board and incorporate limb lifting into the rehabilitation programme. Progress hydrotherapy by increasing the speed of the belt and use extra resistance from the water jets. The owner can allow the patient to have short periods of off-lead exercise in a controlled confined space.

Discharge

The patient would normally be discharged from physiotherapy at around 12 weeks assuming she has achieved the goals defined by the physiotherapy problem list. If the patient has not progressed as expected, she may require further physiotherapy or referral back to her own veterinary surgeon for further investigation.

Limb amputation

Most small animals have the ability to ambulate on three limbs; they can adapt well to the change, and maintain a good quality of life. Amputation may be performed as a salvage procedure following extreme trauma to a limb, or it may be an elective procedure; for example, in the case of bone neoplasia the limb may be amputated.

An accurate medical history for the animal must be taken to ensure the rehabilitation programme is suitable for the individual animal. If the animal has neoplasia with chest metastasis he may have reduced stamina so the physiotherapy programme needs to reflect this and be adapted to meet the animal's and owner's needs.

Consideration must be given to the loading on the other limbs following amputation. This is especially important should the animal be overweight; if this is the case the animal should also be on a calorie-controlled diet. If a thoracic limb has been amputated the contralateral forelimb will have an increased load through the joints. Keep in mind that dogs take 60% of their bodyweight through their thoracic limbs. If a pelvic limb has been amputated the animal may learn to distribute its weight diagonally onto the contralateral thoracic limb.

Ideally the animal would not be overweight, have good ROM in all joints in the remaining three limbs, have no concurrent joint disease such as osteoarthritis, and good muscle mass and strength in the remaining three limbs.

However, the animal will still be at risk of secondary complications due to the change in weight-bearing through the limbs. Rotation of the spinal column towards the side of the amputation often occurs, especially if the animal has poor balance. This can lead to permanent changes and stiffness in the skeletal spine and associated muscle imbalances resulting in chronic pain.

It is important to educate the owner on lifestyle changes for the animal following amputation. If the dog previously jumped in and out of the car this may now be impossible or inappropriate for the animal. The dog may previously been taken on very long daily walks. The energy requirement for an amputee to walk is much greater than for its quadrupedal counterpart, and this should be taken into consideration. The animal may find shorter, gentler walks most enjoyable following amputation.

Until recently in veterinary practice it has been normal procedure to amputate the whole of the limb. Recent developments in veterinary practice include fitting animals with prosthetic weight-bearing devices. This type of surgery in animals is still in its early stages and is by no means a routine elective procedure.

Physiotherapy rehabilitation programme post limb amputation

Early phase (0–2 weeks)

- Control pain and encourage wound healing with laser therapy.
- Reduce swelling at the surgical site using cold therapy.
- Reduce compensatory muscle soreness using massage, heat therapy and STR techniques.
- Reduce load on adjacent hind limb, use The Soft Quick Lift™ sling to support the patient and to assist him with maintaining his balance.

Mid-phase (2–4 weeks)

- Begin muscle strengthening exercises.
- Introduce proprioceptive and balance exercises.

Late phase (4–6 weeks)

- Begin to introduce functional activities (stairs, getting in and out of car consider using a ramp).
- Improve CV fitness and stamina. If available use a UWT, the water will support the patient, and he may be able to exercise for longer.
- Increase the duration of walks, and reduce the support from the sling if able to.

N.B. Be aware of the additional energy requirement the amputee will face, so pace the rehabilitation programme to the patient's ability levels, and do not allow him to fatigue.

Elbow joint

The elbow consists of three main bones:

- Humerus.
- Radius.
- Ulna.

The articulations of these bones make up the three joints of the elbow:

- Humero-radial.
- Humero-ulnar.
- Proximal radio-ulnar.

The medial and lateral collateral annular ligaments support these joints. The main nerves associated with the thoracic limb are:

- Radial nerve.
- Median nerve.
- Ulnar nerve.

Damage to any of these nerves can occur with luxation of the elbow joint.

Elbow dysplasia

'Elbow dysplasia' is a general term used to describe various developmental abnormalities within the elbow joint. It is a relatively common finding in canines, especially large breeds such as Labradors and Rottweilers. Elbow dysplasia may be classified as:

- Fragmentation of the medial coronoid process (FMCP).
- Osteochondritis dissecans (OCD) of the medial condyle.
- Un-united anconeal process (UAP).
- Un-united medial epicondyle.
- Elbow joint incongruity.

Presentation

- Often young dogs 6–9 months old.
- Thoracic limb lameness – often bilateral.
- Flicking of carpi when walking, elbows often abducted.
- Painful elbow joint on manipulation.
- Reduced ROM in elbow, especially flexion with supination (increases pressure on medial coronoid process resulting in pain).

- Crepitus.
- Muscle atrophy.

Elbow dysplasia – fragmented medial coronoid process (FMCP)

This condition results in possible fragmentation of the medial coronoid and cartilage erosions resulting in elbow pain and instability.

Aetiology

- A form of osteochondrosis (micro fractures).
- Found secondary to elbow incongruity and abnormal loading through the joint.
- A short radius (resulting in increased pressure on medial coronoid process).
- Leads to trochlear notch dysplasia (resulting in increased pressure and pain).

Diagnosis

- Plain radiographs (sometimes not obvious).
- CT.
- Arthroscopy.

Treatment

- Medical management (NSAIDs, rest).
- Arthroscopic removal of osteochondral fragment.
- Debridement of underlying bone and removal of loose cartilage.
- An ulnar osteotomy may be considered in severe cases.

Elbow dysplasia – osteochondritis dissecans (OCD)

Osteochondritis dissecans (OCD) is a failure of endochondral ossification. A tear develops in the cartilage leaving a flap, which leads to pain and inflammation within the joint. The condition is often seen in

large and giant breeds of dog; the elbow or other joints (shoulder, stifle) can be affected.

Aetiology
OCD lesions are often found on the medial humeral condyle, seen as a cleft or flap in the cartilage.

Diagnosis
- Plain radiographs (sometimes not obvious).
- CT.
- Arthroscopy.

Treatment
Removal of flap arthroscopically and curetting of underlying bone.

Elbow dysplasia – un-united anconeal process (UAP)

Un-united anconeal process (UAP) occurs when the anconeal process fails to fuse with the olecranon.

Aetiology
- A form of osteochondrosis.
- Found secondary to elbow incongruity and abnormal loading.
- A long radius, results in pressure on humerus and anconeal process, which in turn becomes un-united.
- Leads to trochlear notch dysplasia (resulting in increased pressure and pain).

Diagnosis
- Plain radiographs (usually obvious).
- Do not radiograph before 4–5 months of age as there could be a secondary centre of ossification.

Treatment

- Removal has variable results and can lead to an unstable elbow.
- Ulnar osteotomy, to remove the pressure and allow fusing, is not always successful.
- Lag screw fixation and ulnar osteotomy is technically difficult to achieve but the results are good.

Long-term progression of osteoarthritis is inevitable.

Elbow dysplasia – incongruity

Aetiology

- Unknown.

Diagnosis

- Plain radiographs (difficult as limb position influences interpretation).
- CT is more reliable than radiographs.
- Arthroscopy.

Treatment

Ulnar shortening/lengthening procedures.

Elbow dysplasia – prognosis

- Variable.
- Secondary osteoarthritis inevitable in all cases.
- Outcome improved if cartilage erosions are reduced in extent on arthroscopy.

Incomplete ossification of the humeral condyle (IOHC)

This is a failure of bony union between humeral condyles, predisposing to humeral condylar fractures.

Aetiology
Unknown. *Almost exclusively seen in springer spaniels*.

Treatment
Transcondylar screws if clinically affected.

Elbow trauma
- Traumatic luxation, mainly lateral due to anatomy.
- Fractures of the distal humerus.
- Olecranon fractures.
- Ulnar fractures with radial head luxation.
- Radial fractures.

Traumatic luxation
Clinical signs
- Lameness.
- Increased elbow width.
- Reduced extension.

Diagnosis
Radiographs to confirm.

Treatment
- Closed reduction.
- Open reduction internal fixation (ORIF).
- Ligament repair.

Aftercare
If no ligament damage present:
- Robert Jones dressing for 1 week.

- Two weeks controlled lead exercise.
- (ROM will be reduced).

If ligament damage present:

- Splint for 2 weeks.
- Four weeks' lead-controlled exercise.

Commence passive flexion-extension exercises following support removal.

Fractures of the distal humerus

- Lateral condyle (most common).
- Medial condyle (less common).
- Y-fracture (complex).
- T-fracture (complex).

Fractures of the lower thoracic limb

Fractures of the proximal ulna with luxation of the radial head have a guarded prognosis. Secondary complications of osteoarthritis, reduced elbow motion, nerve damage and reluxation of the radial head are common. The elbow joint is a high motion joint and physiotherapy plays an important role in improving ROM once the fracture has consolidated.

Olecranon fractures usually require open reduction and internal fixation (ORIF); stabilisation of the olecranon needs to be such as to eliminate the pull of the triceps muscle, which inserts on the olecranon.

Proximal fractures of the radius are uncommon. Growth plate fracture may be seen in immature animals. Articular fractures require accurate anatomical reduction to minimise secondary osteoarthritic changes. Comminuted fractures carry a poor prognosis; fracture healing times and weight-bearing through the limb may be prolonged.

Fractures may be managed conservatively using casting/splinting methods versus open reduction internal fixation (ORIF) methods.

CASE STUDY: PHYSIOTHERAPY REHABILITATION PROGRAMME FOR A FRACTURED ELBOW REPAIR

Introduction

Bruno is a 2-year-old, male, entire springer spaniel referred to physiotherapy following a left thoracic limb distal humerus lateral condyle fracture (open reduction internal fixation) repair.

Presenting condition (PC): 5/5 lame on left thoracic limb following road traffic accident (RTA). Radiographs demonstrate left thoracic limb distal humerus lateral condyle fracture.

Past medical history (PMH): nil of note. Bruno is up to date with routine vaccinations and worming.

Drug history (DH): short course of NSAID post-surgery, nil at present.

Social history (SH): Bruno was a working gundog, and the owner would like Bruno to return to work if possible. Previously Bruno was kennelled outside with other working dogs, and again the owner would like him to return to this. The owner drives a 4 × 4 vehicle and Bruno would previously jump in and out of the car.

Bruno is now 6 weeks post-operation, and has been referred for physiotherapy.

Physiotherapy assessment

Gait: 2/5 lame on the left thoracic limb. Abducts affected limb when ambulating and in stance.

Posture: reduced weight-bearing through the left thoracic limb, shifting weight onto right thoracic limb.

Static weight-bearing: left thoracic limb 40%, right thoracic limb 60%.

Joint ROM: reduced end-of-range passive elbow flexion and extension of the left thoracic limb.

Muscle length: tight biceps, rhomboids and pectorals, reduced scapular mobility left thoracic limb.

Muscle mass: reduced bulk triceps, infra and supraspinatus left thoracic limb.

Conscious proprioception (CP): normal left thoracic limb.

Pain score: consider if the patient has a functional lameness following surgical intervention, or if the lameness is due to pain. Inflammation of the joint, discomfort on manipulation and a positive response to analgesia would suggest the patient is in pain. Pain scored 2/4.

Aggravating factors: does exercise increase pain and lameness?

Easing factors: does the patient respond positively to rest or analgesics?

Severity, Irritability, Nature (SIN): How severe is the pain (0–5)? How irritable is the pain; does it settle quickly with rest? What is the nature of the pain – myogenic, arthrogenic, neurogenic, inflammatory or something else?

Problem list

1 Left elbow joint pain.
2 Reduced left thoracic limb elbow ROM.
3 Muscle imbalance of the affected limb.
4 Reduced left thoracic limb weight-bearing and function.
5 Reduced muscle bulk/strength.
6 Impaired gait pattern.
7 Reduced stamina and fitness.

Goals

1 Reduce left elbow joint pain (2–6 weeks).
2 Improve left thoracic limb elbow ROM (6 weeks).
3 Improve muscle length and strength (6 weeks).
4 Improve weight-bearing and function of left thoracic limb (6 weeks).
5 Improve muscle bulk/strength (6 weeks).
6 Gait re-education (6–12 weeks).
7 Improve stamina and fitness (6–12 weeks).

Treatment

- Laser treatment of elbow joint to reduce pain and inflammation and control scar tissue.
- PROM exercises within comfortable range for the patient, three sets of 10 repetitions.
- Passive stretches of tight biceps and pectorals into resistance and hold for 15 seconds, repeat three times.
- Active exercises to encourage weight transfer onto the affected limb (weaving cones), and also to promote adduction and abduction of the limb.
- Cavaletti poles to encourage flexion and extension of the affected joint.
- Weight-bearing exercises over a physio *peanut ball.* By passively moving the peanut ball forwards and backwards the patient will place and take weight

through the affected limb. Passive side-to-side movement will encourage the patient to place and take weight through the limb laterally and medially. This exercise will also challenge and therefore improve balance and core stability.

- A UWT can be used to encourage weight-bearing and function of the affected limb; because of the buoyancy effect of the water less concussive forces will pass through the joints, plus the warmth of the water will mean the patient will find this a comfortable environment to exercise in.

A combination of active exercises, including the UWT, can be used to strengthen the muscles around the joint and improve bulk and therefore improve stability of the joint. The UWT is also useful to re-educate gait; the water level can be adjusted to encourage strengthening, and exercising in a water treadmill has also been shown to improve the ROM of joints. The speed of the belt can be increased to encourage the patient to take longer strides. The duration of time the patient exercises in the UWT can be increased to improve fitness and stamina; this can be further enhanced by using water jets to add in resistance.

Owner education will focus on gradually increasing the patient's level of activity in a controlled manner, so lead exercise only should be advised initially. At 6 weeks postoperatively a callus will begin to form and the limb should be stable enough to allow weight-bearing through the limb. However, the repaired fracture site will not be consolidated until 12 weeks, and remodelling of the fracture will continue for up to 12 months. Uncontrolled exercise and jumping should be strongly discouraged; until remodelling is complete exercises can be increased after a satisfactory 12-week check, and with the permission of the veterinary surgeon.

Evaluation

Aim to evaluate treatment and the patient's progress at regular intervals. If he is not progressing as expected question if you need to change your treatment approach or should he be reassessed by the veterinary surgeon if his condition is not improving as expected.

Progression

Assuming the patient is improving and achieving the goals drawn up from the problem list it is important to progress his rehabilitation programme to prevent him plateauing. Remember, the overall aim of the rehabilitation programme is to return the patient to his highest level of function without ongoing disability. Progression may be to increase the speed of the exercises, add in more weaving

cones to encourage weight transfer onto the affected limb, or increase the height of the cavaletti poles to increase elbow flexion ROM. Note that all exercises should be graded and gradually increased as over-exercise may cause exacerbation of symptoms.

Outcome measures

1. Outcome measures should be taken at the initial assessment to record baseline, and re-measured to assess the patient's progress at week 6, when changes in muscle mass can be expected, and repeated again at discharge, which in many cases would be around week 12.
2. Use a pain measure scale to evaluate the pain score.
3. Measure PROM of the affected elbow using a goniometer (flexion and extension), and compare with the contralateral limb.
4. Measure weight-bearing through limbs; it is worth measuring all four limbs. Knowing where the patient is shifting his weight from the affected limb is useful in identifying possible secondary complications occurring in the overloaded limb.
5. Measure muscle bulk of the affected limb with a tape measure, and compare with the contralateral limb. Aim to take the measure from the belly of the biceps/triceps muscle for consistency; moreover, as the patient builds muscle mass this will show around the muscle belly.
6. Video gait pattern at initial assessment, and use this to compare the gait pattern over time as the patient progresses.
7. Measuring heart and respiratory rate before and after exercise will give an indication of the patient's level of fitness.

CASE STUDY: PHYSIOTHERAPY REHABILITATION PROGRAMME FOR A FRACTURED RADIUS AND ULNA, LEFT THORACIC LIMB (OPEN, COMMINUTED)

Introduction

Otis is a 6-year-old, male, neutered lurcher.

Clinical history

Otis presented as an emergency; he had sustained an open fracture of his left thoracic limb after catching his foot in a hole whilst running. On presentation he was quiet but alert and was able to stand on his other three limbs.

Investigations

Preanaesthetic blood work did not reveal any significant abnormalities.

Radiographs of the affected limb revealed a comminuted proximal diaphyseal radial fracture of the ulna and radius. Examination under general anaesthetic confirmed the open nature of the fractures. There was a large U-shaped wound on the flexor surface of the left elbow region with avulsion of the skin from the underlying subcutaneous tissue (Figure 1.10).

Diagnosis

Fracture of the left thoracic limb – radius and ulna (open, comminuted).

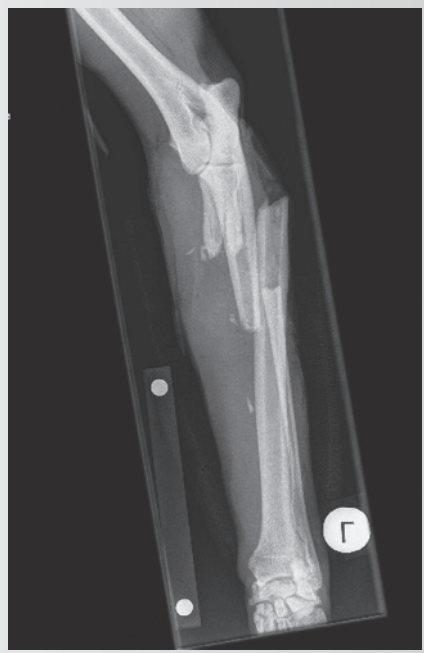

Figure 1.10 A left cranio-caudal fractured radius and ulna.

Surgery

A 1.6-mm Steinmann pin was placed in retrograde fashion to restore ulnar alignment. A modified type 1B external skeletal fixator was applied with one full pin through the olecranon, one half pin laterally in the proximal ulna, and four half pins in the mid to distal diaphysis and metaphysis. It was not possible to apply fixation to the proximal radius due to the presence of multiple fissure lines. Prior to closure a cancellous bone graft was harvested from the ipsilateral proximal humerus and applied to the radial fracture site. Antebrachial muscle and subcutaneous tissue was closed with 3/0 PDS® (polydioxanone) Suture (Ethicon) in simple interrupted pattern (Figure 1.11).

Figure 1.11 Post-fracture repair. The image shows the patient following surgery with a dressing on the left thoracic limb.

Reassessment

Otis presented for reassessment 6 weeks after antebrachial fracture repair. He was found to be only weight-bearing on the affected limb perhaps 10% of the time and showed generalised muscle atrophy of the brachium. The carpus and elbow had reduced ROM.

Investigations

Radiographs taken under sedation revealed maintenance of apposition and alignment and progression of fracture healing (Figure 1.12). Palpation revealed no instability at the radial fracture site.

Comment

Otis's fractures had healed sufficiently for the fixator to be removed. It was hoped that the use of his affected limb would gradually improve and he was referred for physiotherapy to encourage this. Ongoing remodelling at the

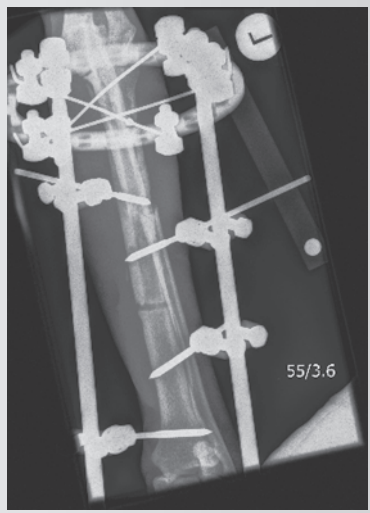

Figure 1.12 A left cranio-caudal radius and ulna repair.

fracture site was expected so his exercise at home was restricted to on-lead activity for the next 4–5 weeks.

History

On presentation Otis was partial weight-bearing through the left thoracic limb; however, he remained considerably lame. He had a short left forelimb stride with reduced left elbow and carpal flexion during gait. There was muscle atrophy of the left triceps and deltoid muscles. He had relatively good ROM of the left elbow with almost full extension and 140° of flexion with some discomfort at end of range. Left carpal flexion was reduced by 20° most likely as a result of soft tissue shortening and scar tissue. In addition Otis had soft tissue tension in the musculature of the right thoracic limb as a result of over using that limb to compensate for the left thoracic limb.

Physiotherapy assessment

Subjective

The owner reported that Otis is doing well with short lead walks.

Objective

- *Gait* – lame left thoracic limb 2/5 (scale 0–5), pain limits function.
- *Joint ROM* – hyperextension of left carpus 220°, flexion reduced 20°.
- *Muscle mass* – atrophy of left triceps, and deltoid 3 cm difference between right and left thoracic limb, mild muscle tension in right biceps, triceps and deltoid.

Problem list

1 Pain in the affected left limb.
2 Reduced ROM in the left carpus.
3 Muscle imbalance in the left thoracic limb.
4 Reduced function in the affected left limb with compensatory muscle tension in contralateral right limb.
5 Reduced strength in the left thoracic limb.
6 Altered gait pattern.
7 Reduced fitness.

Goals

1 Reduce pain (2 weeks).
2 Improve ROM (2–6 weeks).
3 Improve muscle imbalance (6 weeks).
4 Improve function and reduce compensatory muscle tension (6 weeks).
5 Improve strength (6–12 weeks).
6 Gait re-education (6–12 weeks).
7 Improve fitness/stamina (6–12 weeks).

Treatment

- Laser treatment of the fracture site and carpus to reduce pain and inflammation.
- Left carpal soft tissue release (STR), to regain normal ROM of the carpal joint.
- Left carpal mobilisations, grade II-III, 3 × 10 to reduce pain and improve ROM of the carpal joint.
- Biceps, internal rotators, and carpal stretches on the left thoracic limb into resistance and hold for 20 seconds, repeat three times (*N.B. Note the longer hold time for shortened soft tissues*).
- Right thoracic limb STR, to reduce muscle tension.
- Weaving cones 6 × 6, to improve weight transfer and abduction and adduction of the affected limb.
- Cavaletti poles 6 × 6 at 15 m height – reduced left carpal flexion, compensation from shoulder noted.
- Wobble board with limb lifting, increased extension left carpus noted, when additional weight passing through the limb.
- Hydrotherapy using an underwater treadmill 4 × 4 minutes at 6 kmp with resistance, water to the level of the elbows, good movement of left thoracic limb in the water observed.

Analysis (conclusion)

Reduced ROM, strength and function, post radius and ulna fracture repair; pain limits function. Consider using a carpal splint to improve ROM, function and strength of the affected limb.

Evaluate treatment

- Pain score at 6 and 12 weeks and compare with baseline measures.
- Measure passive joint ROM (compare with right thoracic limb) at 6 and 12 weeks.
- Measure muscle bulk (compare with right thoracic limb) at 6 and 12 weeks.
- Measure percent weight-bearing through limbs (compare with baseline measures, taken at initial assessment, measure at week 6 and 12).
- Gait assessment and score lameness, video gait at baseline, compare at 6 and 12 weeks to evaluate effectiveness of physiotherapy programme (Video 1.3).

Progress treatment

- Increase length of walks and add in inclines, to improve stamina and strength.
- Introduce stairs, as a functional activity.
- Increase the speed and duration of time exercising in the hydrotherapy sessions.

VIDEO 1.3

Gait/lameness scoring. When the patient walks towards the camera a mild lameness and head bob can be seen in the affected left thoracic limb, which is also hyperextended. At trot this is more obvious and the patient's head bob is more obvious. Gait lameness score grade 2/5.

Tendon injuries

Tendon injuries result from a partial or complete rupture of the muscle-tendon junction. These injuries involve over-stretching of the muscle-tendon fibres and are often traumatic in origin; they are seen most frequently in sporting breeds such as racing greyhounds.

Conservative treatment can be effective for mild tendon injuries, using the PRICE regime (Figure 1.13).

Surgical tendon injuries

Acute lacerations and avulsion tendon injuries usually require surgical intervention. The goal is to try to gain good apposition of the two ends of tendon to avoid excessive scar tissue, which can lead to

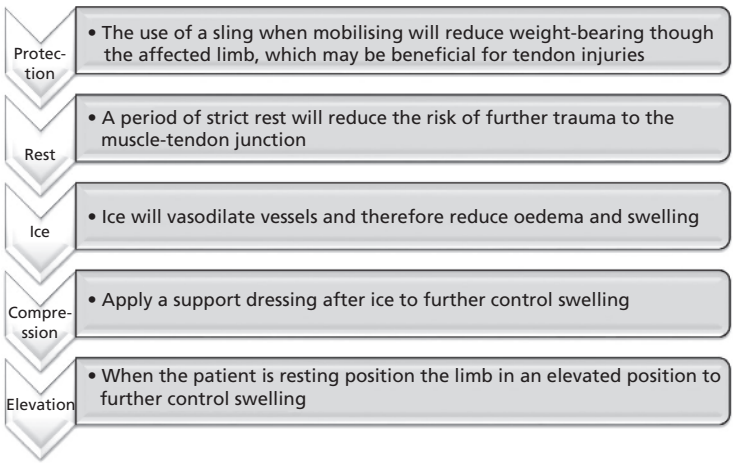

Figure 1.13 The PRICE regime for conservative treatment of musculoskeletal injuries.

adhesions and shortening of the tendon. Tendon and ligaments also tend to have a poor blood supply, meaning they can take a long time to heal and regain tensile strength.

Postoperatively a cast is usually applied to offer protection to the tendon repair. The cast may be applied to prevent loading of the affected limb and to keep the tendon repair in a shortened state. This cast would usually be left in place for 6 weeks and the usual cast care criteria would apply. If there is a lot of associated soft tissue swelling postoperatively the original cast may be reapplied within the first week, as the swelling subsides the cast will become lose and may cause skin irritation and tissue ulceration.

When the cast is removed and the veterinary surgeon is happy with the tendon repair gentle PROM exercises and stretches may begin. When the tendon is cast in a shortened position this will also affect the associated muscles, which will become short and tight.

It may take weeks of graded stretching of the limb to achieve normal weight-bearing on the affected limb.

Shoulder instability

Shoulder instability, which may also be described as shoulder subluxation or glenohumeral instability, is characterised by an increase in the joint ROM, most commonly seen in the medio-lateral plane. Physical examination will demonstrate a passive increase of the abduction angle with the animal in lateral recumbency. This is caused by tearing or weakening of the medial or lateral glenohumeral ligaments and subscapularis tendon (medial damage will increase limb abduction angle, lateral damage will increase limb adduction angle, subscapularis damage will affect scapular stability).

Conservative treatment

- 6–12 weeks restricted exercise.
- Analgesia.
- Physiotherapy aims to strengthen the muscles around the shoulder joint to reduce instability and reduce the risk of associated secondary osteoarthritis.

Physiotherapy plan

Laser therapy is applied using a continuous movement pattern directly over the affected area. In the early stages the aim is to reduce pain and inflammation. In the later stages the aim is to reduce adhesions and shortening of tissues associated with excessive scar tissue.

Weaving cones can encourage limb abduction and adduction. Start with the cones spread far apart then as the patient progresses bring the cones closer together.

Walking in figures-of-eight and circles will increase abduction and adduction. Again, start with wide circles and figures, and as the patient progresses lead in smaller circles and figures-of-eight.

Place a wobble cushion under the affected limb; this unstable surface will challenge the subscapularis muscle and work to stabilise the scapula. Challenge the patient further by incorporating limb lifting of the contralateral thoracic limb, then the contralateral pelvic limb. Remember to support the patient under the abdomen and trunk as necessary. As the patient progresses further a wobble board may be used, this can be used to target and challenge abduction and adduction of the affected limb, by rocking the board medially and laterally; as the patient resists this motion he will strengthen his abductors and adductors. Rocking the board forwards and backwards with the animal facing forwards will load the limbs in a cranio-caudal plane. The wobble board also improves core stability and challenges balance. It is most effective if introduced slowly so the patient can become accustomed to the equipment; start with short sessions. As the patient progresses limb lifting can be incorporated to challenge the patient further. Remember to support the patient under the abdomen and trunk as necessary. If the patient feels secure he is more likely to accept the equipment and exercise.

Hydrotherapy using a UWT can be used in the acute stage to encourage weight-bearing through the affected limb. The buoyancy effect of the water can be used to reduce the load passing through the limb. At this stage the level of the water should be at approximately mid-trunk. The speed of the treadmill belt should be less than the patient's normal gait speed to encourage use of the affected limb.

As the patient progresses the water can be used to provide resistance and the level of the water should be set to mid humerus as; the most resistance is at the water surface. The speed of the treadmill belt can be gradually increased over a period of weeks to increase stamina, and resistance from water jets may be used to further increase strength.

In the early stages (first 6 weeks) stretches of the structures around the shoulder joint should be avoided. The ligaments supporting this joint are already overstretched and weak. Gentle stretching may commence after 6 weeks if there is reduced passive ROM of the shoulder

joint associated with soft tissue shortening. Note that joint passive ROM may also be reduced if the patient has osteoarthritis in the affected joint.

Surgical intervention aims to reconstruct the ligaments supporting the shoulder joint. The challenges of reconstructing the ligaments of the shoulder joint are similar to those in other limb ligament reconstructions. Tendons take a long time to heal; weight-bearing should be avoided for 6 weeks postoperatively to avoid loading the fragile ligament repair.

Active physiotherapy would usually commence following a satisfactory 6-week postoperative check from the veterinary surgeon. The physiotherapy plan following surgical reconstruction of the ligaments would aim to strengthen muscles around the shoulder joint, improve weight-bearing and function of the affected limb. Challenge balance, and address any secondary compensatory issues the patient may have adopted from the original injury.

Biceps tenosynovitis

Biceps tenosynovitis results from inflammation of the biceps brachii tendon, which may be the result of direct or indirect trauma to the bicipital tendon. Often the cause may be related to repetitive use or over-use and is therefore often seen in agility and sporting breeds. The biceps tendon is a stabiliser of the shoulder joint, and biceps tenosynovitis may occur in conjunction with generalised shoulder instability.

Physical examination

Gait: the animal will usually present lame on the affected limb, with abduction of the limb to reduce weight-bearing; reduced ROM at the shoulder joint to reduce pain and inflammation around the tendon and sheath may be observed.

Palpation: direct palpation over the tendon using the back of the hand may indicate heat – a sign of inflammation; this should be

compared with the non-affected limb. The tendon itself may also feel thickened when compared to the non-affected limb.

ROM: may be reduced as a result of adhesions and excessive fibrous tissue forming around the tendon and its sheath.

Pain: end-of-range flexion of the shoulder joint will produce pain as the tendon will be fully stretched. Osteophytes may form within the intertubercular groove causing further irritation and inflammation of the tendon.

Radiography: changes may be unremarkable in the acute stage as osteophytes do not form until the later more chronic stage.

Arthroscopy: will demonstrate tendon disease including thickening and inflammation.

Conservative treatment

- Prednisolone injection into the bicipital tendon sheath (oral prednisolone does not appear to be affective).
- Rest followed by graded, controlled exercise.

Surgical treatment

Bicipital tendon tenotomy or tenodesis generally is associated with good outcomes. The recovery period following surgical treatment is 2–9 months to regain optimal function. Physiotherapy can commence following a satisfactory 6-week postoperative check from the veterinary surgeon.

Physiotherapy

- Laser therapy over the biceps tendon to reduce any inflammation.
- PROM exercises to maintain ROM in the affected limb.
- Stretches to maintain muscle length; do not take the biceps stretch to end of range as this will be painful for the patient.
- Frictions directly over the biceps tendon in a medio-lateral direction 3 × 30 seconds; in the acute phase avoid being too vigorous with friction treatment as this will be uncomfortable for the

patient. Frictions aim to break down adhesions around the tendon and sheath and should be followed with careful stretching of the biceps muscle and tendon.

Active exercises

- Weaving cones to encourage weigh transfer on the affected limb.
- Cavaletti poles to improve ROM and proprioception of the affected limb.
- Stairs are a functional exercise; note that descending stairs may be painful in the early stages as the patient will be fully loading the affected limb so this may be an exercise to avoid in the early stages to prevent exacerbation of the biceps tendon.
- Wobble cushions placed under the affected limb will improve strength around the stabilising muscles of the shoulder. This can be progressed by lifting the contralateral thoracic limb or the contralateral pelvic limb as the patient progresses; remember to support the patient under the abdomen and trunk as necessary.
- Wobble board. As the patient progresses further the wobble board can be used to improve strength and stability of the muscles around the affected shoulder joint as the patient resists the movement of the board.
- Hydrotherapy using an underwater treadmill to provide buoyancy will encourage the patient to use the limb functionally and improve ROM of the affected limb. As the animal progresses the level of the water can be adjusted to strengthen the muscles around the shoulder joint and the water level should be set to mid-humerus. The speed of the treadmill belt can be increased to increase stride length, and the duration of sessions can be increased to improve stamina. Finally, resistance from the water jets can be added to improve strengthening.

Outcome measures

Measure baseline ROM of the affected limb using a goniometer; compare against the unaffected limb. Re-measure at 6 and 12 weeks to evaluate progress.

Measure baseline muscle mass, using a tape measure around the muscle belly of the biceps and triceps muscle; compare this against the unaffected limb. Re-measure at 6 and 12 weeks to evaluate progress.

Video gait pattern and score lameness at assessment and record these baseline measures, then re-measure at 6 and 12 weeks to evaluate progress.

Assess weight bearing through the limb

- *Subjective* – how easy is it to pick up the affected limb?
- *Objective* – using a pressure-sensitive analysis mat or bathroom weighing scales will also give an idea of where the patient is shifting his weight, indicating that he is placing additional stress on these limbs, and may be at risk of developing secondary compensatory complications. Measure baseline at assessment; re-measure at 6 and 12 weeks to evaluate progress.

Pain management

Multimodal approach

An understanding of the patient's pathology is essential when considering a pain management approach. Excellent handling skills when moving and assisting patients to mobilise will minimise pain and lead to an earlier return to function with reduced secondary complications such as muscle imbalances or the development of abnormal postures.

Gate control theory

The gate control theory (Figure 1.14) was first introduced by Melzack and Wall (1965). Three types of fibres are associated with the gate control theory:

- A-delta fibres.
- C fibres.
- A-beta fibres.

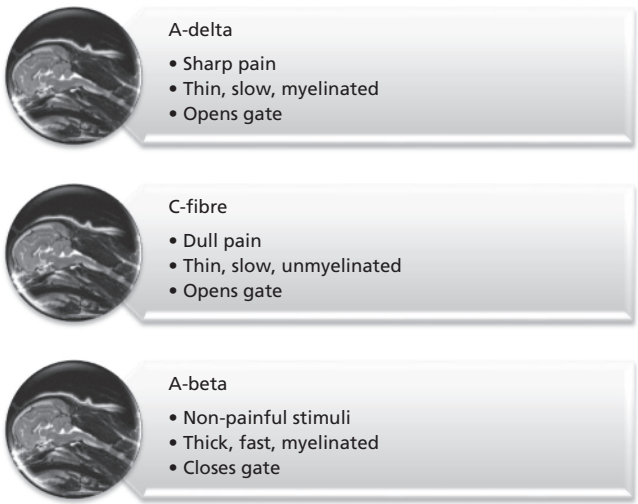

Figure 1.14 Gate control theory.

A-delta fibres transmit sharp, prickly pain signals; the fibres are thin and myelinated, and transmission is slow. C fibres transmit a dull, aching pain signal; the fibres are thin and unmyelinated, and transmission is slow. When stimulated A-delta and C fibres open the pain control 'gate' and pain is perceived in the brain.

A-beta fibres when stimulated can act on inhibitory neurons to block transmission of painful stimuli via the A-delta and C fibres to the brain. A-beta fibres are large, thick and myelinated, and they transmit fast signals. When A-beta fibres are stimulated the gate is closed and pain is not perceived in the brain.

It is thought that TENS machines control or modulate pain perception by stimulating the A-beta fibres, and inhibiting input from the A-delta and C fibres.

Also many naturally occurring substances can inhibit pain perception:

- Endogenous opioids (encephalins, endorphins).
- Adenosine.
- Norepinephrine.
- Dopamine.

Severity

Consideration should be given to the severity of pain. Many human pain scales are available such as the visual analog scale (VAS); this is a pain measure scale ranging from 0 to 10, where 0 would be the patient's perception of no pain whatsoever, and 10 would correspond to the worst pain imaginable by the patient. The VAS has been shown to have excellent validity and reliability in humans. However, the VAS could not be applied to animal patients, as they are unable to give subjective feedback. An alternative is the Glasgow composite measure pain scale – short form (GCMPS-SF).

The GCMPS-SF has been shown to be a valid measure of pain in animals and has intra-rater (observer) reliability. Valid and reliable measures of the severity of the patient's pain will guide the veterinary surgeon when administering analgesics. The GCMPS-SF should be used in conjunction with the expected duration of analgesics administered. For example, if the analgesic has a 4-hour duration of effectiveness, the GCMPS-SF should be completed at the end of the 4 hours. The score of the GCMPS-SF will guide the veterinary surgeon in his or her choice of analgesics. If the pain appears under control the same analgesic regime may be continued in the early postoperative stage, or a decision may be made to taper the dose of analgesia, or to switch from a pure opioid to a partial opioid.

A simple pain score scale (0–4) can be useful for grading pain during the physical examination when manipulating the affected joint (Table 1.4).

Table 1.4 Pain score scale 0–4.

Score	Description
0	No signs of pain during manipulation of the affected joint
1	Signs of mild pain during palpation of joint
2	Signs of moderate pain during palpation
3	Signs of severe pain during palpation
4	Dog will not allow examiner to palpate joint

Irritability

The irritability of pain should also be considered. The irritability of pain is related to the duration of pain. For example, the pain experienced by the patient may be severe, but relatively short lived; if this is the case a potent analgesic may be selected, but only a short duration of analgesia is required. This is worth considering if the animal has undesirable side effects from opioid analgesics. Pain would be considered as irritable if once triggered the level of pain takes several hours to settle. In this case an analgesic with a long duration of action would be selected.

Nature

The nature of pain is another consideration. *Myogenic* or *muscular pain* is described in humans as a dull, aching pain. It tends to have a VAS of around 5/10 and is often related to fatigue or overuse. Myogenic pain can last for several hours but it responds well to rest and heat therapy if spasm is a feature of the pain.

Inflammatory pain may be associated with stiffness. This may be seen early in the morning when the animal rises. Gentle movement and controlled exercise can reduce the pain. Inflammatory pain is also associated with surgery; the veterinary surgeon may use a short course of NSAIDs in conjunction with opioids in these cases.

Neurogenic pain can be associated with sharp, shooting pains, and altered sensation and loss of function in humans. The severity and

irritability of neurogenic pain can vary. Accurate pain scoring using a valid and reliable measuring tool will guide the veterinary surgeon in choosing an appropriate analgesic regime for each individual patient.

Many other types of pain are recognised in humans, and many types of analgesics are available to relieve pain. A multimodal approach is most beneficial as often myogenic, inflammatory and neurogenic pain can co-exist within a single patient. Severity and irritability must be considered when using a pain measuring tool such as the GCMPS-SF as these are dynamic variables.

Analgesics

The analgesic regime will be devised and regularly reviewed by the veterinary surgeon. The veterinary nurse should be confident in using pain measuring tools and reporting any changes in the patient's pain level to the veterinary surgeon.

Physiotherapy musculoskeletal assessment

Ensure familiarity with the surgical procedure or condition of the patient; liaise with the veterinary surgeon if in any doubt.

Gait: assess the patient's weight-bearing status through the affected limb(s). Is he NWB, PWB or FWB? Is this what you would expect to find? For example, NWB status would be expected in the early rehabilitation phase, PWB in the mid-phase, and FWB in the late phase.

Palpate the surgical site for signs of inflammation (redness, swelling, pain, heat)/infection, and loss of function. Again inflammation is to be expected in the early phase, but not in the mid and late phases. Infection should not be present at any stage and should be reported to the veterinary surgeon immediately.

Joint ROM: This may be reduced in the early phase and ROM may be limited by inflammation and pain. In the mid-phase joint ROM should improve as inflammation and pain subside. In the late

phase joint ROM should be normal for that patient, providing he has received adequate rehabilitation. *N.B. If osteoarthritis is present or developing secondary to surgical intervention ROM will be reduced at end of range, and a bony end feel will be noted; the patient will feel discomfort at this point.*

Muscle length: Muscles can become imbalanced if the patient has prolonged lameness and reduced function in the affected limb. Muscles often work in pairs, so if the triceps in the thoracic limb becomes weak, because the patient is NWB on this limb, the opposing biceps muscle, which will be contracted to hold the limb in flexion, will become short and tight. During the early phase of rehabilitation NWB status is desirable; however, with sling support PWB status is desirable in the mid-rehabilitation phase to minimise muscle imbalance associated with long-term misuse of a limb. In the late phase of rehabilitation normal muscle length without imbalances should be achieved.

Muscle bulk/strength: Muscle bulk should be measured with a tape measure around the circumference of the limb at the level of the muscle belly, as this is where changes in muscle mass will be most apparent. Measure three times and use the average measure; compare the measure against the non-affected contralateral limb where possible. Record these measures as *baseline.* This outcome measure should be repeated at 6 and 12 weeks to evaluate progress.

Muscle tone: may be described as:

Normal tone is the resistance expected when the limb(s) are passively flexed and extended.

Hypertonic tone is when increased resistance is observed during passive limb flexion and extension exercises.

Hypotonic tone is when decreased resistance is observed during passive limb flexion and extension exercises.

Posture: This is the observation of the patient's alignment and body symmetry. If the patient is lame his alignment and symmetry will change; if this change in alignment is not addressed secondary complications or compensatory postures may develop.

Secondary complications/compensatory postures: Secondary complications include muscle imbalances, which may be associated with altered function and weight-bearing through the limbs. Compensatory postures can develop if a patient has a prolonged period of lameness leading to poor posture and alignment with associated *trigger points* in the compensating overused muscle groups. Secondary complications and compensatory postures can lead to chronic pain. Patients who develop compensatory postures may demonstrate:

Kyphosis – defined as an abnormal curve or flexion of the spine, usually in the thoracic spine. It may be caused by abnormal vertebrae or by a developmental abnormality. Animals who present with a lesion in the thoracic spine will often adopt a kyphotic posture; this may be an attempt to relieve pressure from an intervertebral disc protrusion or extrusion. This posture is also often observed in the patient following hemi-laminectomy and decompression of the spinal cord, the surgery itself is very invasive and a degree of swelling and inflammation around the surgical site is normal. Over time the swelling and inflammation will subside and the patient's spinal posture should become normal again.

Lordosis – refers to an inward curve usually in the lumbar spine.

Scoliosis – is an abnormal curvature of the spine to either the right or left side.

Subjective examination

The subjective examination focuses on information obtained from the owner, or on something you have read in the medical notes. It may be useful to record this information on a body chart.

- *Localisation of symptoms:* The aim is to identify the painful areas. For example, if the patient has hip dysplasia mark this on the chart as *pain a*; if this is a chronic condition the patient may well have referred pain in the lumbar spine as a result of secondary compensatory issues, so mark this on the chart as *pain b.* Generally 'pain a' will be more severe than 'pain b', so if 'pain a' can be controlled 'pain b' will tend to resolve also.

- *Intensity of pain:* Ask the owner how lame the patient is. The owner may inform you that the patient is stiff in the morning when he rises but then 'walks it off' as the day progresses. Is the patient guarding the affected area? Is he reluctant to be examined? Score for pain and lameness.
- *Intermittent or constant?* Is the pain intermittent and if so does it relate to exercise levels? Or does the patient appear to be in constant pain? Constant pain would indicate a high level of irritability and his analgesia may need to be reviewed by the veterinary surgeon. Ask about easing and aggravating factors i.e is rest or exercise a factor.
- *Abnormal sensation (numbness):* Does the animal respond to changes in temperature? Can he distinguish between hot and cold? Does he have a normal withdrawal reflex when you 'pinch' between his toes? Is it the same when compared to the contralateral limb?
- *Relationship of symptoms:* If the patient presents with lameness, is it the cause of the spinal pain, or is the lameness an effect of the spinal pain? If the lameness is the cause of spinal pain the limb pain is the primary pain, and the spinal pain is secondary, or sometimes classed as referred pain. However, if the spinal pain is causing the lameness the spinal pain is the primary pain and the limb pain is the secondary pain. As a general rule the primary pain will be more severe than secondary pain. Palpate the individual areas and pain score them separately to distinguish between primary and secondary (referred pain).
- *Check other relevant regions:* If the patient presents lame on the thoracic limb but no pain can be localised in the limb, check for cervical spine pain, which may be the primary cause of the lameness.

Behaviour of symptoms

- *Aggravating factors* –the lameness may be associated with long walks, or lying in one position for a long time, then the patient may be stiff to rise.
- *Easing factors* – symptoms may improve with rest, or if heat is applied to the affected area.

- *Severity* – this is closely linked with the intensity of symptoms; pain score for a baseline measure then re-measure at regular intervals to evaluate progress.
- *Irritability* – this is linked to the duration of the pain; i.e. if the patient rests or heat is applied to the affected area do the painful symptoms decrease? If the pain decreases quickly it is not very irritable; however. if the pain lasts for several hours or even days it would be classed as very irritable.

  Pain severity and irritability are often correlates; e.g. pain from a recent fracture fixation would be considered to be severe and irritable. However, over time both the severity and irritability of pain would normally decrease.
- *Daily activities/functional limitations* – how much exercise does the patient usually have? Does the patient have to climb stairs to go outside? Can he jump in and out of the car?
- *24-hour behaviour* – does the pain disturb the patient's sleep? Does he seem more painful first thing in the morning, or does the pain develop through the day? Inflammatory type pain disturbs sleep and is common early in the morning. However, as the patient begins to move around the pain and stiffness generally ease. Myogenic pain tends not to be severe, and is described as a dull aching pain in humans. It may be related to overuse, and will usually reduce with rest. Neurogenic pain is severe and it may or may not be irritable. It is worth noting that several different types of pain can co-exist in a single patient at the same time, so a multimodal approach to pain relief will be required.
- *Stage of the condition* – is it an acute or chronic injury? Is the condition improving, staying the same or getting worse? If the condition is improving continue with the same treatment. If the condition is static it may be that the patient has reached a plateau, so the treatment should be changed or progressed. If the patient is getting worse change the treatment; maybe go back a step if the rehabilitation programme is too advanced for him, or refer him back to his veterinary surgeon for a review.

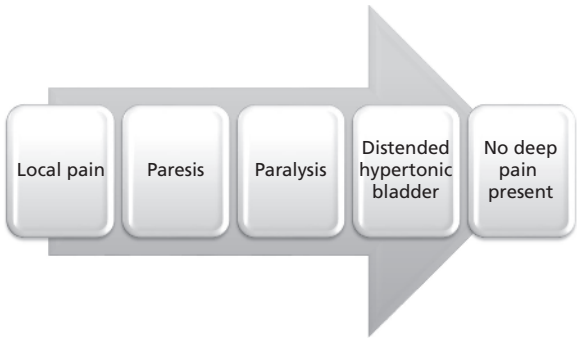

Figure 1.15 Progressive signs of spinal cord or cauda equina symptoms.

Special questions

Does the patient have spinal cord or cauda equina symptoms? If so urgent bladder management will be required, followed by an immediate referral to a neurologist (Figure 1.15).

History of present condition (HPC)

- *Mechanism of injury* – did the owner observe the injury, i.e. 'the dog jumped to catch the ball, twisted awkwardly, cried out in pain, and was immediately weak on the back leg.'
- *Change of each symptom since onset* – is the pain getting better, staying the same, or getting worse?
- *Recent X-rays or investigation* – review findings and discuss with colleagues as necessary.

Past medical history (PMH)

- Relevant medical history.
- Previous episodes of present complaint.
- Previous treatment and outcome.
- General health.

Drug history (DH)

- Current medication.
- Steroids.
- Note any allergies.

Social history (SH)

- Age and gender.
- Home situation (stairs, access to garden, other pets and children in the household).
- Exercise (normal level pre-injury or -illness).

Physical examination

Observation

- *Posture* – weight shifting off affected limb(s).
- *Function* – ability to climb stairs, or jump in and out of car.
- *Gait* – ability to walk, trot and run.
- *Structural abnormalities* – kyphosis, lordosis, scoliosis.
- *Muscle bulk and tone* – measure muscle circumference and compare with contralateral limb. Is the muscle tone high, normal or low?
- *Soft tissue* – assess for signs of pain/trigger points. Assess muscle length/imbalance.

Passive joint movements

- Passive joint ROM – measure in degrees using goniometer.
- Joint effusion measurement, using a tape measure and compare with contralateral limb.

Muscle tests

- *Muscle strength, control and stability* – can use limb lifting with support as necessary to test how much weight is passing through the affected limb, or by observation of functional activities, such as stairs, which challenge strength, control and stability.
- *Muscle length* – assess by passively stretching muscles; observe any 'tightness' or muscle contractures, which may be common in muscles that cross two joints such as biceps and quadriceps.

Neurological tests

If indicated test:

- Reflexes.
- Conscious proprioception.
- Withdrawal.
- Sensation.

Palpation

- Palpate the skin and superficial soft tissues – assess for heat (use back of hand, compare with contralateral limb) and oedema.
- Palpate muscles and tendons – assess for muscle tension or *trigger points,* assess tendons for signs of inflammation or abnormal tracking.
- Ligaments – assess stability and note any laxity.
- Joints – assess for pain and stiffness.
- Bones – note any abnormalities, i.e. limb valgus or varus.

Self-assessment questions

1 In cases of hip dysplasia, which passive movement of the coxofemoral (hip) joint is usually most restricted and painful?
- **a** Flexion
- **b** Extension
- **c** Adduction
- **d** External rotation

2 If an animal is 5/5 lame in the left pelvic limb for more than 2 weeks, what changes can be expected in the affected limb?
- **a** Generalised muscle atrophy, tight hip flexors, and weak hamstrings.
- **b** Generalised muscle atrophy, weak hip flexors, with strong hamstrings.
- **c** An increase in muscle mass.
- **d** No muscle changes.

3 Incomplete ossification of the humeral condyle (IOHC) is a condition mostly seen in:
- **a** Labradors
- **b** German shepherd dogs

c Toy poodles
d Springer spaniels

4 When considering the pain gate control theory, which of the following would lead to pain perception in the brain?
a Adenosine
b Norepinephrine
c C fibre stimulation
d Dopamine

5 Which of the following inhibits pain perception in the brain?
a A-delta fibres
b A-beta fibres
c C-fibres
d Projection cells

6 Which of the following is not considered to be a strengthening exercise?
a Underwater treadmill walking
b Swimming
c Stair climbing
d Passive range of motion exercises

7 When using electrotherapy, when must dark-green lens glasses be worn for eye protection?
a TENS machine
b Laser machine
c PEME therapy
d Therapeutic ultrasound machine

8 Which of the following is not a naturally occurring opioid?
a Methadone
b Encephalin
c Endorphin
d Dynorphin

9 Which exercise would most challenge a patient's balance?
a Walking around weaving cones.
b Weight-bearing through a limb placed on a wobble cushion.
c Stepping over cavaletti poles.
d The patient standing with all four limbs on a moving wobble board.

10 What is the sequence of cranial cruciate disease events?

a Stifle instability, articular cartilage degeneration, capsular fibrosis, reduced ROM.

b Articular cartilage degeneration, stifle instability, capsular fibrosis, reduced ROM.

c Stifle instability, articular cartilage degeneration, reduced ROM, capsular fibrosis.

d Stifle instability, capsular fibrosis, reduced stifle ROM, articular cartilage degeneration.