Getting Started with Physiotherapy Mini Series

Session 3: Nutrition, Training and Nurse Clinics

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Nutrition and Training

Very little accurate information exists as to what is the most appropriate dietary composition for dogs across all stages of life. However, achieving the correct balance of nutrients to maximise repair and remodelling whilst maintaining lean body weight is critical for rehabilitation. Equally importantly is being able to instigate feeding strategies to promote athletic activity or to facilitate weight loss in certain individuals. With respect to the canine athlete there is a need for discipline specific nutrition with sprinting dogs requiring readily available glycogen stores for energy while endurance breeds will need to adapt to using fat as the major energy source.

It is not easy to predict the daily calorie requirement for an individual. The Daily Energy Requirement (DER) is a measure of the daily calorie requirement for the maintenance of body weight and condition and varies wildly from animal to animal. The Resting Energy Requirement (RER) is the amount of calories required by an animal at rest in a thermoneutral environment and does not support exercise, growth or reproduction. The RER is determined by (Kg body weight).^{75} x70. For active and working dogs, the following calculations have been used:

Light work - 2x RER

Moderate Work - 3x RER

Heavy work - 4-8x RER

Environmental changes can influence nutritional requirements on a daily basis. These can include:

Heat increases work and water loss

High humidity impairs evaporative cooling

Cold increases energy requirements for thermogenesis

Excitement or stress can increase body temperature and respiratory rate and therefore enhance enzymic activity and increase metabolic rate.

Geriatric nutrition

The specific requirements of the geriatric animal have not been widely studies. Metabolic changes associated with ageing include:

Reduction in total cell mass

Reduction in protein stores

Protein to fat ratios fall

Decline in efficiency of immune system due to changes in differentiation of T lymphocytes

Decreased phagocytosis and chemotaxis

Organ related changes

The physical effects of ageing include:

Percentage of body weight represented by fat increases

Skin becomes thickened, hyperpigmented and less elastic

Footpad’s hyperkeratinize

Muscle, bone and cartilage mass are lost

Lungs loose elasticity, fibrosis occurs and pulmonary secretions become more viscous

Vital capacity is reduced

Urinary incontinence develops

Cardiac output may decrease

Number of cells in the nervous system decreases

As veterinary surgeons and nurses involved in the dietary management of the geriatric patient we are primarily involved with Obesity management and being able to provide a diet that meets all nutritional requirements, is low in calories and has a high satiety factor.

Weigh gain is a significant issue within the canine population. Owner's perception of what is an appropriate body condition score for athletic activity is often far to heavy to facilitate injury free performance and can impair training. Recent studies have shown that over 40% of dogs in the Western World are overweight. It is essential that the calorific requirements of an individual be calculated and adjusted to reflect the level of activity. A good diet should provide adequate nutrients, support lean body mass development and provide adequate satiety. High protein diets(>30% DM) can support lean body mass and promote weight loss though the exact mechanism is unknown. It may be associated with the higher metabolic rate of lean body mass or due to other alterations in metabolism remain unclear.

Fiber has also been used as a way of decreasing dietary calorific intensity. Increased volume also promotes satiety and this can often be achieved through switching from wet to dry feeding.

As individuals age, skeletal muscle mass declines. Often this is exacerbated by senior dog diets which restrict protein. Often, leaner older dogs have decreased digestive capacities and require food that is relatively calorie dense and high in good quality protein. Studies have shown that older dogs require twice the amount of dietary protein (5g of protein per Kg body weight) as young dogs (2.5g protein per Kg body weight) to maintain hepatic and skeletal muscle protein turnover. Some individuals may therefore require performance rations to maintain adequate protein intake.

Foods suitable for patients with early osteoarthritis should contain long chain omega3 fatty acids. The most common source of fat in most pet foods comes from saturated, monounsaturated and polyunsaturated fatty acids. The polyunsaturated fatty acids come from plant, animal or marine sources. Plant sources supply linoleic acid and omega 6 fatty acidor alpha linoleic acid and omega 3 fatty acids. The canine metabolism can elongate these fatty acids into 20carbon fatty acids such as arachindonic acid or eicosopentanoic acid. AA is a precursor to the normal production of eicosanoids (Prostoglandin E2 and Leukotriene B4) through cycloxygenase and lipoxygenase enzyme activity. These are also involved in the inflammatory response. Therefore if EPA or Omega 3 is substituted for AA in the diet, less proinflammatory eicosanoids are produced. This should result in less cartilage degradation and due to lower metalloprotease and local cytokine production, allowing for better collagen and glycosaminoglycan production.

The Omega 3 chain length is important. Short chain omega 3 such as flax oil (alpha linoleic acid) may not be as beneficial as the longer chain Omega 3's found in marine oil. A dose of 1g EPA per 10Kg body weight is effective.

Nutrition of the Canine Athlete

Dietary fat and Carbohydrate

Studies have shown that when animals are working at up to 40% of their VO_{2max} they will primarily use fat as an energy source. Between 40-70% they will use a mixture of glucose and fatty acids and above 70 %, glucose becomes the main energy source (Toll et al, 1992, Reynolds et al 1995). During the first few seconds of exercise, energy is provided by the phosphocreatine system. Quickly however, glycogenolysis soon follows. Carbohydrate becomes the main source of energy for long term exercise (20min -2hrs) as long as there is glycogen present. Eventually, as glycogen is depleted, protein oxidation will take place. As glycogen depletes, dogs can not sustain oxygen consumption above 50-60% $VO_{2max.}$ After 30min of exercise fatty acid oxidation starts to rise and will be sustained at 30-50% VO_{2max} and facilitates endurance exercise for numerous hours. Thus fat can form the basis of canine endurance diets as opposed to human diets where carbohydrates predominate. This may be due to the dog's increased mitochondrial density and capillarisation in skeletal muscle compared to humans. In anaerobic athletes however, studies have shown that performance has been improved by diets high in carbohydrates (Hill et al 1999).

Carbohydrate loading is used in human athletes. It may be beneficial in sprinting athletes and in those individuals competing in mixed sports such as all terrain races, agility, canicross and trialling. It may also be

beneficial when athletes are competing over the course of a day and over several days in a row where muscle glycogen is depleted (Reynolds et al 1997). Studies on sled dogs have demonstrated that the provision of maltodextrin supplement at 1.5gm/Kg BW within 30min of exercise increases skeletal muscle glycogen(Hinchcliff et al 1997a, 1997c.). Thus there may be a rationale for making carbohydrate available post exercise.

Dietary Protein

Dietary protein helps maintain muscle integrity and appropriate Total Protein, Albumin and RBC status. The exact requirements for protein in the canine athlete remains open to debate. Whilst endurance athletes do appear to benefit (in terms of Plasma Volume, haematocrit and haemoglobin concentrations) from diets high in easily digestible animal protein, performance in sprinting dogs appeared to decline. (Hill etal 2001b).

Feeding Strategies

The timing and frequency of feeding can be critical in the canine athlete. Feed to close to an event and performance will be impaired, however lack of energy substrate can lead to lack of focus, loss of performance and ultimately collapse through hypoglycaemia. In athletes undergoing sustained athletic activity, preloading in the days preceding the competition may assist with making glycogen and fatty acids available.

Feeding for rehabilitation

There are three major nutritional considerations which must be addressed, namely:

Obesity Prevention

Provision of adequate nutrients to promote lean body mass

Reducing the inflammatory component of the diet.

Feeding for Healthy Growth and Development

Being overweight is a major risk factor in developing An overweight body condition, due to excessive caloric intake, is an important risk factor for developmental orthopaedic disease.

Feeding for maximum growth and ‘free’ feeding of puppies increases this risk as does the overuse of training treats.

The second major risk factor is feeding diets unbalanced in Calcium/Phosphorus ratios. High Calcium ratios have been shown to contribute to DOD in large breed puppies. A calcium content of 1.5% dry matter is advisable in juvenile diets. There are no hard and fast rules for switching away from puppy food. It is best done when the pup has developed an adult sized frame - 9-12months typically. At this stage the demand for energy and protein falls and therefore a less calorie dense food can be introduced.

Canine developmental considerations

Play should form an important part in juvenile development. A direct correlation has ben found between play and cerebellar growth. The more a pup plays, the bigger the prefrontal cortex. EEG studies on a 7 week old pup brain demonstrated similarities with the adult brain. However although they can process new information rapidly, overload soon happens and therefore training sessions should be short and repeated frequently. Key training points include:

Make it fun

Keep sessions short

Remain Calm

Repeat frequently

Avoid high impact work

Focus on skill

Individual in nature

The Heart and Lung Function in Exercise

The heart and lungs or the cardiorespiratory function during exercise is often overlooked during training and rehabilitation.

Cardiorespiratory endurance is the ability of the body as a whole to exercise for extended periods of time. Cardiorespiratory training aims to improve the delivery of Oxygen to skeletal and cardiac muscle. The more efficient we are at doing this then the more energy we can generate aerobically and therefore muscle fatigue and soreness is reduced.

Oxygen delivery is facilitated through:

Nostril dilation

Increase in depth and rate of respiration or breathing

Increased blood flow to the tissues involved in breathing

Improved transportation of oxygen around the body

The harder we exercise, the greater the need for oxygen. Our maximum rate of oxygen consumption or VO2Max is genetically determined and will ultimately determine our athletic ability. With training, an individual can increase their rate and efficiency of Oxygen delivery up to this genetically determined limit. During exercise, the heart rate will increase in line with this increase in demand for oxygen. During training, stroke volume increases thus enabling tissue oxygen delivery at lower heart rates. During exercise also, the amount of blood flowing to various tissues alters. Blood flow to the heart itself and the muscles of the limbs is maximised at the expense of blood flow to the internal organs. Blood flow to the respiratory system is also increased. Since training can increase the total volume of circulating blood this results in an increase in the volume of Haemoglobin which carried Oxygen around the body and therefore a net increase in overall oxygen carrying capacity and delivery to the tissues is seen.

Training

The aim of training is to positively influence exercise physiology to maximise performance.

Training should therefore aim to:

Improve muscle strength

Improve muscle endurance

Improve cardiovascular fitness

Improve balance and co-ordination

Increase suppleness and flexibility

Once a basic level of fitness is reached then the demands of each individual discipline will alter the focus of training. Factors such as age and injury status must also be considered. Ideally, training at the appropriate level should start from an early age.

In the young (skeletally immature) animal, the focus should be on developing balance, co-ordination and proprioceptive awareness. High impact, repetitive or high intensity exercises should be avoided as they can lead to abnormal loading of the soft tissues, bones and the joint surfaces. The net result being an increased risk of orthopaedic damage or injury to the musculoskeletal system at a later stage. In general, short duration, low intensity and novel exercise regimes repeated frequently work the best. In this way the musculoskeletal system is given time to adapt and develop appropriately in the face of a challenge and it is therefore primed for when the intensity of exercise increases.

If the onset of training is delayed however, a crucial window in the development of the neuromuscular system may close and the animal may well never reach it's genetic potential. Lack of challenge or limiting exercise to a sterile, flat environment may deprive the neuromuscular system of the challenges it requires to improve balance, co-ordination and proprioception. Since bones, tendons, ligaments and the articular cartilage all develop in response to the stresses and strains put on them, a lack of appropriate stress can again leas to weaker structures at the end of the day. Delaying the onset of training may also predispose to lack of flexibility in adulthood which in turn may predispose to injury when performing.

Training And Injury Prevention

The racing greyhound and the racing sled dog lie at opposite ends of the athletic spectrum. Genetics as well as training determine an individual's performance at these extremes. The former is the 100m sprinter to the latter's marathon runner and neither is likely to perform well in the other's discipline. Other breeds however take up the middle ground, with the majority being more akin to the endurance type of dog in make up. Agility and flyball require an individual with a combination of speed and strength while working dogs and those involved in canicross require excellent muscle endurance.

Basic Training

Cardiovascular Training

The primary aim of cardiovascular training is to improve Oxygen delivery within the body and to increase the amount of aerobic energy produced. Since it has so far not been possible to determine the maximum rate of oxygen delivery or VO2max in dogs, we have to extrapolate across from human values.
The maximum heart rate (HRMax) achieved during exercise does show variation between species in the dog – from 300 beats per minute in crossbreds to 330beats per minute in the greyhound. By extrapolating across from human values, the following figures can be assumed:

Training at 70% HRmax – 50% VO2Max – early training range

Training at 80% HRMax – 70% VO2max – moderate or medium intensity training

Training at 90-100% HRMax – 80-100% VO2max – High intensity training

Techniques For Improving Cardiovascular Fitness

Continuous training

Interval Trainining

Training For Muscle Strength And Endurance

Skeletal muscle will show significant changes in response to training. Whereas the cardiovascular system responds rapidly to training, changes within skeletal muscle occur much more slowly. Studies in horses have shown that it can take 16 weeks to detect changes within the muscle itself. These changes are mainly associated with the muscle's ability to transport oxygen and include an improvement in blood supply through an increase in capillary density. One of the other major changes is associated with the biochemistry of the muscle i.e. how efficiently it can change food substrates into energy.

During training, you potentially an increase in the number and diameter of the individual muscle fibres should occur. For a muscle to increase in strength, it must be forced to work at a higher level and unfortunately many of the techniques employed in human strength training are unfeasible in animals. However techniques that load the muscle while it is changing length i.e. during movement can be used with care such as pulling weighted sleds or working with resistance bands. The degree to which an overall increase in muscle mass can be achieved will also depend on breed and age. Certain breeds such as greyhounds and members of the mastiff family have a higher proportion of Type I muscle fibres which are the type of muscle fibres responsible for generating power. It is therefore much easier to increase muscle mass in these breeds than in for example a Malamute or Husky which are genetically adapted to have a higher proportion of Type II muscle fibres which are endurance or postural in nature.

The ability to increase muscle fibre numbers decreases with age, so older animals will show a reduced response and reduced tolerance to training compared to young but skeletally mature individuals.

Basic training regimes

The greyhound and the sled dog will have the same basic training requirements in terms of musculoskeletal adaptation. Skill development should form an important component of the basic training regime however. Therefore, since greyhounds need to be able to corner at high speed, skills to foster excellent balance and develop core stability should be developed form the start.

During training, it is essential that the animal does not become tired or stressed by the regime, therefore play can form an extremely important part of training. It can also assist with the canine-trainer bond. By working on different surfaces such as dunes, grass, river beds, proprioceptive skills are enhanced and such work should also help develop balance and improve co-ordination.

Jogging or free running over different terrain can be a very effective way of progressing an animal through basic training. Ideally, 40min sessions 3-4 times a week should be introduced to assist with the development of aerobic fitness. By varying the route and using novel terrain it prevents boredom and again assists with the development of core stability and proprioception.

Sub strenuous/resistance training

At this point, high intensity exercises are introduced gradually. These can further enhance aerobic performance and should progressively increase the load on muscles. Interval training should now start and discipline specific training should start. Techniques to foster proprioception and co-ordination should continue.

Strenuous Interval training

Once a basic level of fitness is achieved, further improvement can only be gained through increasing the intensity of the exercise – it is not sufficient to increase the duration of the training session. Again, this is best achieved through intense interval training. Care should be taken however to avoid overtraining and the individual should be carefully monitored for any change in health status, behaviour and interaction with others as these can all be early signs of overtraining and should be recognised before they progress to disease or lameness.

Taper

Over the two weeks leading up to a competition, then the intensity of the exercise or training should be tapered off. Ideally training volume should be reduced by 25% in week 1 and by a further 25% in week two. The training intensity should remain the same however.