

**RECENT FINDINGS ON TYING-UP®**  
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'Tying up' is the term for a type of muscle disease in horses. It is also known as exertional rhabdomyolysis, azoturia, paralytic myoglobinuria and Monday morning disease. The causes and severity vary between horses and even in a particular horse, one attack may be very different from the next in severity, duration and intensity of exercise prior to the episode.

There is also wide variation in susceptibility to 'triggering' factors, which include:

- genetic muscle disorders
- vitamin E and/or selenium deficiency
- delayed muscle soreness from free radical damage
- hormonal disturbances
- thyroid disorders
- electrolyte imbalances
- diets high in raw grain which can result in carbohydrate overloading
- viral and bacterial infections
- abnormal muscle calcium levels

It is generally the hind limbs that are affected, with the semitendinosus, semimembranosus and gluteal muscles most often involved. Diagnosis is based on veterinary clinical assessment. Plasma muscle enzyme levels are used to confirm muscle damage and to assess the severity of the damage and the recovery of the animal. Creatine Kinase (CK), Aspartate Amino Transferase (AST) and Lactate Dehydrogenase (LDH) are the most commonly measured enzymes. The differences between these enzymes in time to peak concentration, can indicate whether the muscle damage is active or resolving. CK levels generally peak within the first 4 to 12 hours, and may reach values of 10,000+ IU, with AST and LDH levels reaching peak levels 12 to 24 hours after. The rate of return of the enzymes to resting levels is also very different with CK back to normal within several days, whereas the AST levels may take weeks.

Horses that 'tie up' repeatedly are referred to as 'chronic'. Chronic tying up may be due to Polysaccharide Storage Myopathy (PSSM) or to Recurrent Exertional Rhabdomyolysis (RER). Polysaccharide storage myopathy is a condition in which there is an accumulation of glycogen (a form of glucose) in muscle tissue. The glycogen that accumulates is abnormal in structure and prevents the horse from using the normal glycogen that is stored in muscle for use during exercise. Affected horses have the classical elevated muscle enzymes on a blood test and to diagnose PSSM requires muscle biopsies. This condition has a genetic basis and is most common in Quarter horses.

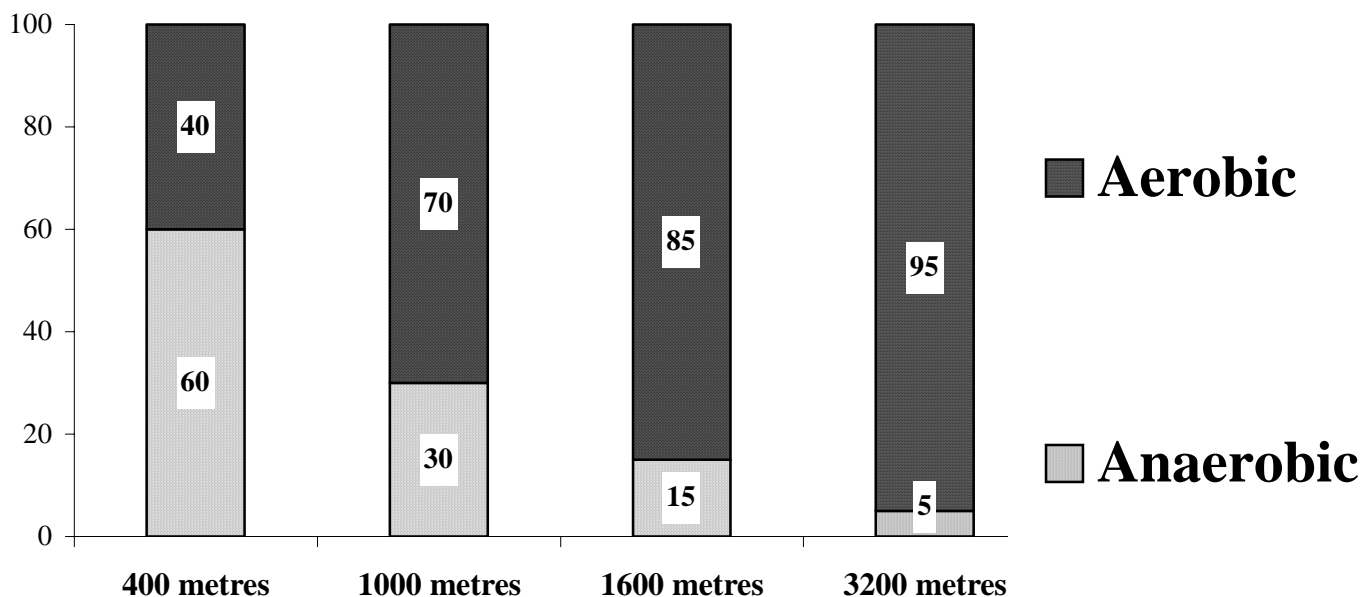
Recent research has found that when horses that suffer chronic tying up or RER have a tying up episode, they have abnormally high levels of calcium trapped inside the muscle cells. Calcium is required for muscle contraction and to relax, the muscle must remove the calcium from inside its cells. In horses with RER, the process of calcium removal does not operate efficiently and this leads to an accumulation of calcium within the cell. This prevents relaxation of the muscle fibres, which remain in a state of partial contraction, leading to pain and muscle damage.

One of the misconceptions with tying up has been that it caused by high muscle lactic acid concentrations. However, recent research has shown that muscle lactic acid levels are in fact low in these horses. In addition, few horses tie up after racing, when muscle and blood lactate levels are at their highest.

Further, it is the fast twitch (anaerobic) fibres that are damaged when a horse ties up. The fast twitch fibres provide the extra burst of energy needed to achieve maximum speed and are only recruited when horses perform fast (anaerobic) work. Most horses tie up during slow and medium (aerobic) work – when the fast twitch fibers are not being used. Muscle biopsies have shown that it is the Type II or fast twitch fibres which suffer damage in these horses.

The speed at which fast twitch fibres are recruited and *anaerobic processes* begin depends on diet, fitness, prior training, warm-up and rate of increase in speed. However, aerobic energy production does not stop when anaerobic energy processes start. The graph below shows that aerobic processes continue - and still provide the majority of muscle energy - even at top speed. Anaerobic energy serves to 'top up' aerobic supply. A blood lactate of greater than 4 usually indicates that a horse is working anaerobically.

**% OF AEROBIC AND ANAEROBIC ENERGY FOR  
DIFFERENT EXERCISE DISTANCES**



The latest findings on blood lactate measurement are also exciting developments for trainers wanting to tailor work programs for individual horses. Sports Scientist, Dr Allen Davie at Southern Cross University, Lismore, has been fine-tuning the

technique for thoroughbreds in training at both metropolitan and regional tracks. Measurement of blood lactate allows close matching of workload to fitness so that work program and racing campaign can be fine-tuned for each horse. Some horses are genetically superior in terms of the ability to remove lactate from the blood and this equates with athletic performance. Trainers in Australia and overseas are using Dr Davie's for gauging ability, preparing the training and racing schedule and predicting performance. His recently published book\* is a valuable tool for owners and trainers wishing to keep abreast of current trends and make practical use of recent advances in sports and exercise science.

This offers an explanation as to why some horses tie up shortly after they begin slow or medium work (ie aerobic exercise). When such horses are excited or under stress, they release increased amounts of the hormones that mobilise energy and stimulate muscular activity. However, these hormones stimulate the high anaerobic energy system, ie the fast twitch fibres, resulting in increased lactic acid concentrations. Removal of lactic acid from the muscle cells requires a high rate of blood flow, but as these horses are only doing slow to medium work, blood flow to the muscles is only moderately increased. Because of the slow rate of removal of lactate it accumulates within the muscle cells. The high concentration of lactate within the muscles reduces the capacity of the cells to remove calcium and hence their ability to relax.

One of the treatments for these horses is to control their environment, by reducing stress levels, decreasing carbohydrate or raw grain intake, using oil-enriched feeds such as Mitavite Formula 3 and maintaining fibre intake. An added benefit of oil-enriched feeds is that they provide sufficient calories to assist nervous horses in maintenance of body weight, while reducing the weight handicap of a heavy gut.

Most equine diets are too low in magnesium and the horses with responsive behaviour problems (sensitive to touch/sound, "jumpiness" in general) are sensitive to the low intake. Magnesium is critical to the normal functioning of an estimated 350 enzyme systems in the body. It is particularly critical to skeletal muscle, the nervous system and glucose metabolism. Symptoms of magnesium deficiency include: muscular symptoms from twitching to high muscle tension to cramping to spasm; hypersensitive to touch and sound; shying/spooking; anxiety and nervousness in general; abnormal glucose metabolism.

Magnesium deficiency is also strongly associated with hypertension in humans and correction of magnesium intake is always part of my approach to a horse that has bled. Imbalances in the calcium:magnesium ratio are associated with tying up, especially in fillies and mares when oestrogen influences mineral balance when they are in season. Magnesium helps a lot of horses who tie up, regardless of sex.

Other management practices recommended for preventing further episodes include:

- Not overexerting unfit horses. Sound planning of training programs with a carefully controlled progression of work load assists horses in coping with the stress of training.
- Increased electrolytes prior to working in the heat to compensate for heavy sweat losses.
- Substitute the raw grain with steam-extruded grains and oil-enriched racing formulations that ensure adequate vitamin and mineral intake.

- Minimise the amount of time in the stable to help reduce excitability.
- Vitamin E and selenium. Both these vitamins have a vital role in protection of the cell from the toxic ions that are produced during exercise. Both are antioxidants, and work as scavengers against the toxic products produced by the muscles energy system which can damage muscle cells. However, there is still a question mark over whether increasing the intake of Vitamin E and selenium will act as a protection against this damage.
- **Omega 3 oils** reduce inflammation in both human and veterinary medicine. These oils also have profound effects on red blood cell flexibility and oxygen transport. There are 3 types of Omega 3 oil (EPA, DHA and linolenic acid). The beneficial effects of Omega 3 supplementation occur when all 3 are present – labelling of supplements must be checked to ensure that all 3 types are present.
- With chronic tying up (RER), avoiding warming-up and instead beginning the training session with fast work prior to slow and medium work, has been employed by some trainers with varying degrees of success. When slow work and warm up were skipped and horses worked at around 14 to the furlong for 600-1200m, depending on fitness, they did not tie up. The following table shows heart rate and speed that is fast enough to stimulate fitness without causing muscle damage.

Management of Horses that Tie Up				
Stage of Work	Distance (metres)	Speed (m/sec)	Heart Rate(bpm)	Lactate (mmol/L)
Early work	600m	13m/sec	210-220	8
Medium work	600m	14m/sec	210-220	6
Fast work	800m	15m/sec	210-220	12

- hard work should be followed with a slow trot or canter to stimulate delivery of oxygen to the muscles and removal of lactic acid to the liver

As a general guideline, this changing of the work schedule has been of benefit to many horses. However, it is important that an accurate diagnosis of the cause of tying up in individual horses is combined with tailored adjustments to the work load and the final program is based on the trainers assessment and judgement for each horse.

The great advances in our understanding of disease processes allows modification of training and feeding regimes so that many of the conditions associated with athletic training may be prevented. For more information on feeding horses, Mitavite racing formulations and Mitavite PERFORMA 3 containing blended ratios of Omega 3 fatty acids, contact Mitavite