

# Tying-Up

*(set fast, azoturia, Monday morning disease, exertional rhabdomyolysis)*

*Dr J H Stewart BVSc BSc PhD MRCVS*

Muscle disorders are a frequent cause of poor performance in horses and **'tying up'** is the most common syndrome. Some horses are more susceptible than others. There appears to be a genetic component and a hormonal influence as the condition is more common in fillies. It is also more common in horses that are highly strung.

It is often mistakenly assumed that any horse with muscle pain or cramping after exercise has **'tied-up'**, and because of this there is a lot of confusion and controversy around the causes, diagnosis, and management of affected horses. Although a number of different muscle conditions produce the same signs, there are basically two types of true **'tying-up'**:

**1. ACUTE STIFFNESS DURING OR AFTER EXERCISE** The most common cause is hard exercise that exceeds the horse's fitness level. Horses with respiratory viruses and subclinical infections are at increased risk.

**2. REPEATED 'TYING-UP'** Horses that suffer recurring stiffness after mild exercise, often have a history of poor performance and subclinical cases (reduced performance - but no stiffness or unevenness of gait) can occur.

Horses that 'tie up' repeatedly are referred to as 'chronic'. Chronic tying up is sometimes referred to as Recurrent Exertional Rhabdomyolysis (RER), or Polysaccharide Storage Myopathy (PSSM). One of the misconceptions with tying up has been that it is caused by high muscle lactic acid concentrations. If this was the case all horses would tie up after a race. 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.

## **Polysaccharide Storage Myopathy (PSSM) Recurrent Exertional Rhabdomyolysis (RER)**

Researchers have also found that when horses with this form of tying up have episodes of pain, the affected muscles have high levels of calcium trapped inside the muscle cells. Calcium, along with energy (ATP), is required for muscle contraction. 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. This leads to an accumulation of calcium within the cell which prevents the normal relaxation of the muscle fibres. The muscles remain in a state of partial contraction leading to soreness and muscle damage.

This idea 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. These hormones stimulate the high anaerobic energy system, 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. Due to 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.

## **CLINICAL SIGNS:**

- a characteristically painful, shuffling gait
- severe cases may be unable to move, or even recumbent.
- pain may cause sweating, elevated heart rate and rapid breathing - these may be the only signs
- blood tests show elevation of the muscle enzymes - creatine kinase (CK) and AST

**CAUSES:** The classic case is the horse fed high grain and then given a day of rest, hence the name '**Monday morning disease**', however ongoing research has shed a lot more light on the syndrome and its complexity.

Tying up can occur in any horse, but there is wide variation in susceptibility to 'triggering' factors.

Factors known to 'trigger' tying up include:

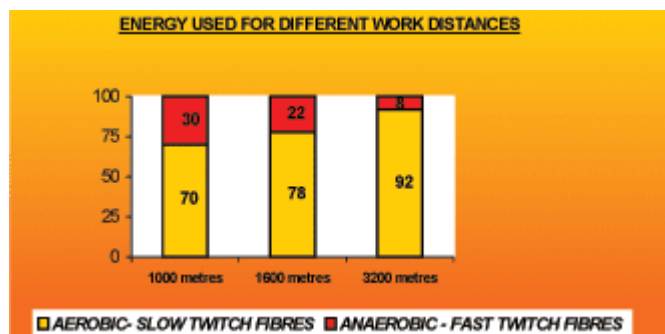
- genetic muscle disorders
- vitamin E and/or selenium deficiency
- hormonal disturbances
- thyroid disorders
- electrolyte imbalances
- diets high in raw grain which can result in carbohydrate overloading
- viral and bacterial infections
- abnormal muscle calcium levels.

Veterinary examination is important if the condition is to be managed correctly. To enable the most accurate treatment and management plan to be developed, it is important to determine which factors are operating in any individual horse. The veterinary investigation may include blood and urine tests, muscle biopsies and an exercise challenge test.

**BLOOD TESTS:** There is wide variation in 'normal' muscle enzyme levels between horses. Some perform well with blood CK and AST levels which would be elevated for other horses. Therefore it is important to have good previous baseline data to establish what is 'normal' for individual horses. In addition, significant elevations in CK can occur with other causes of muscle damage (injections, bruising). Blood tests are important, especially in horses with poor performance to confirm skeletal muscle involvement, assess severity and monitor recovery. Diet analysis is required to detect imbalances of micronutrients, trace elements and electrolytes.

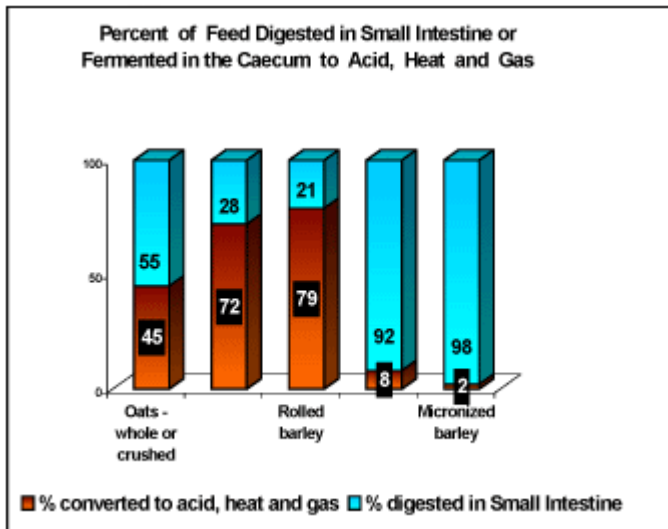
**SUB CLINICAL TYING UP:** This is an important cause of poor performance but can be difficult to diagnose. Afflicted horses may only have elevated heart rates or increased sweating after work. Blood tests are important to correctly diagnose and manage these horses. Elevations of CK to 10,000iu+ can be found in the absence of clinical signs.

**WORK SCHEDULE:** A particularly interesting finding is that it is the fast twitch fibres which 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 work. The graph shows the percentage of energy supplied by fast and slow twitch fibres for different distances.



Many horses tie up during slow and medium 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. Some disorder in fuel/energy utilization occurs in the fast twitch fibres during warm up, slow and medium work.

**PREVENTION AND MANAGEMENT:** Diet and exercise are closely linked to tying-up and the most important preventative strategies are based on a coordinated, controlled program matching diet with exercise intensity.



**1. DIETARY MANAGEMENT:** Essential in this is the provision of a diet with -

- **a minimum level of grain** - High grain diets can overload the normal digestive processes of the small intestine so that the caecum and colon of the large intestine are flooded with undigested and semi-digested grains. Undigested nutrients reaching the large intestine are fermented, which results in increased lactic acid production, fluctuations in blood glucose and hormone levels and increased heat of digestion.
- **balanced vitamin and mineral levels** - especially vitamin E and selenium.
- **the correct amounts and ratios of the different electrolytes.**
- **a high percentage of oil** High oil feeds provide slow release energy, reduce heat and acid production, have a glucose-sparing effect, lower weight handicap and reduce blood lactate levels. To achieve this, oil levels should be between 10 and 12%.
- **Use correctly processed grains:** the latest advances in cooking grains - steam-extrusion and micronization - fine-tune and advance the time-honoured practices of cooking grains for horses. Steam-extrusion and micronization increase grain digestibility from less than 30% for raw grains to over 90% - minimising the risk of grain overload in the caecum.
- Horses on high raw grain diets have more acid in their blood and urine. The use of micronized and steam-extruded grains has been shown to reduce this.
- **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.***

- **Constant access to good quality hay** promotes normal gut function and reduces the risk of acid build up in the caecum.

**Other management practices that have been recommended for preventing further episodes include:**

1. Not overexerting unfit horses. Sound planning of training programs is critical to allow a controlled progression of muscle adaptations to increasing work load. Increase electrolytes in the diet prior to working in the heat to compensate for heavy sweat losses. This is important for maintaining a balance of sodium, potassium and chloride ions.
2. Reducing the quantity of raw grain in the diet. Substitute the raw grain with higher fibre and oil-enriched feeds formulated specifically for the management of horses that tie up and ensure adequate vitamin and mineral intake.

3. Reduction of time confined to stall to help reduce the level of excitability.
4. Vitamin E and selenium. These 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.
5. With the chronic tying up horses, reducing the slow work and incorporating more fast work to activate the fast twitch muscle fibres, has been employed by some trainers with successful results.

**PREVENTION AND MANAGEMENT: Diet and exercise** are closely linked to tying-up and the most important preventative strategies are based on a coordinated, controlled program matching diet with exercise intensity.

**EXERCISE SCHEDULE** : This will vary between horses according to fitness, metabolic rate and individual variation, but several basic principles apply:

- a consistent, structured program with no rest day
- grading the level of exercise with a slow increase in intensity as fitness develops 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
- **horses that tie up during slow and medium work:** such horses may be managed by altering the work program. 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 sufficient 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	190-210	6
Medium work	600m	14m/sec	210-220	8
Fast work	800m	15m/sec	210-30	13

After completing the fast work as outlined above, the distance work is performed. 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.

A fine balance is required between working horses beyond their fitness level and not working them enough to result in increasing fitness. Blood lactate is a measure of how hard a horse is working and how much the fast twitch fibres are being used. It allows matching of workload to fitness so that individual training programs can be tailored to suit each horse.

Ideal treatment and preventative management strategies vary between horses and this is where the 'art' and the 'science' come together. The key to management is the combination of exercise and nutrition science. The 'art' of training lies in knowing when to apply the science.

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.