

# **Exercise-induced muscle cramp.**

A trainer's perspective

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## **What are muscle cramps?**

Cramps are caused by involuntary contraction or over-shortening of skeletal muscle as a result of physical exercise. Cramps are suggested to be caused by cold, heat, overexertion and/or electrolyte imbalance. Essentially there is no evidence to fix the blame on a single agent or cause.

There are no scientifically based protocols for the prevention of cramp in greyhounds that are affected by this exercise-induced muscle cramp. However this has not stopped the marketing of many and varied means of so called cures or preventatives. The purpose of this paper is to add my experience to the mix.

## **Mechanism of Cramp**

According to Bentley<sup>1</sup> disturbances at various levels of the central and peripheral nervous system and skeletal muscle are said to be involved in the mechanism of cramp and may explain the diverse range of conditions in which cramp occurs. The activity of the motor neuron is subject to a multitude of influences including peripheral receptor sensory input, spinal reflexes, inhibitory interneurons in the spinal cord, synaptic and neurotransmitter modulation and descending CNS input. The muscle spindle and golgi tendon organ proprioceptors are fundamental to the control of muscle length and tone and the maintenance of posture (as in the gait of greyhounds and track surface contour). Disturbance in the activity of these receptors may occur through faulty posture, shortened muscle length, intense exercise and exercise to fatigue, resulting in increased motor neuron activity and motor unit recruitment. The relaxation phase of muscle contraction is prolonged in a fatigued muscle, raising the likelihood of fused summation of action potentials if motor neuron activity delivers a sustained high firing frequency.

According to Schwellnus et al<sup>2</sup>, the aetiology of exercise-associated muscle cramps (EAMC), was directly related to the physiological basis for skeletal muscle relaxation, based on recent clinical studies.

They state that electromyographic (EMG) data obtained from runners during EAMC revealed that baseline activity is increased (between spasms of cramping) and that a reduction in the baseline EMG activity correlates well with clinical recovery. Furthermore, during acute EAMC the EMG activity is high, and passive stretching is effective in reducing EMG activity. This relieves the cramp probably by invoking the inverse stretch reflex. In two animal studies, abnormal reflex activity of the muscle spindle (increased activity) and the Golgi tendon organ (decreased activity) has been observed in fatigued muscle. They hypothesize that EAMC is caused by sustained abnormal spinal reflex activity which appears to be secondary to muscle

fatigue. Local muscle fatigue is therefore responsible for increased muscle spindle afferent and decreased Golgi tendon organ afferent activity. Muscles which cross two joints can more easily be placed in shortened positions during exercise and would therefore decrease the Golgi tendon organ afferent activity. In addition, sustained abnormal reflex activity would explain increased baseline EMG activity between acute bouts of cramping. Finally, passive stretching invokes afferent activity from the Golgi tendon organ, thereby relieving the cramp and decreasing EMG activity.

Khan et al <sup>3</sup> determined that when cramp was induced in shortened muscle indicated by presence of EMG, that reflex inhibition of cramp electrical activity was observed following tendon electrical stimulation. Thus muscle cramp can be inhibited by stimulation of tendon afferents in the cramped muscle suggesting that the same reflex pathway was the source of the inhibition in both cases. Thus the cramp-generated EMG is also likely to be driven by spinal synaptic input to the motoneurons. The muscle conditions that appear necessary to facilitate cramp, a near to maximal contraction of the shortened muscle, are also the conditions that render the inhibition generated by tendon afferents ineffective.

Bentley's <sup>1</sup> assumptions are that because muscle spindle and golgi tendon organ proprioceptors are fundamental to the control of muscle length and tone and the maintenance of posture (and as in gait), disturbance in the activity of these receptors may occur through faulty posture, shortened muscle length, intense exercise and exercise to fatigue, resulting in increased motor neuron activity and motor unit recruitment. The relaxation phase of muscle contraction is then prolonged in a fatigued muscle, raising the likelihood of fused summation of action potentials if motor neuron activity delivers a sustained high firing frequency.

#### Causes

In humans the most popular links that may cause cramping are deficiencies of electrolytes, particularly hypokalaemia (a low level of potassium) and hypocalcaemia (a low level of calcium). This disturbance arises in the human body as it loses large amounts of interstitial fluid through sweat.

The causes of EAMC that have been historically proposed, such as (1) inherited abnormalities of substrate metabolism ('metabolic theory') (2) abnormalities of fluid balance ('dehydration theory'), (3) abnormalities of serum electrolyte concentrations ('electrolyte theory') and (4) extreme environmental conditions of heat or cold ('environmental theory'), were not supported by detailed analyses of the available scientific literature including data from recent studies as to the causes of EAMC according to Bentley<sup>1</sup>.

In a recent study, electromyographic (EMG) data obtained from runners during EAMC revealed that baseline activity is increased (between spasms of cramping) and that a reduction in the baseline EMG activity correlates well with clinical recovery. Furthermore, during acute EAMC the EMG activity is high, and passive stretching is effective in reducing EMG activity. This relieves the cramp probably by invoking the inverse stretch reflex. They hypothesize that EAMC is caused by sustained abnormal spinal reflex activity which appears to be secondary to muscle fatigue. Local muscle fatigue is therefore responsible for increased muscle spindle afferent and decreased Golgi tendon organ afferent activity. Finally, passive stretching invokes afferent activity from the Golgi tendon organ, thereby relieving the cramp and decreasing EMG activity.

Cramp is known to occur in greyhounds when changing speed during racing such as stopping entering the catching pen. This is triggered by changed muscle contraction and shortening power and will be observed happening in several cases where the race performance to the winning post was up to standard. On reaching the catching pen, clients should be encouraged to check for cramping of the gracillus and tensor facia area, the most common places.

## **Treatment**

Treatment of cramp is directed at reducing muscle spindle and motor neuron activity by reflex inhibition and afferent stimulation. Massage, stretching and heat are the accepted treatments. Affected greyhounds will accept movement or slow walking with massage to relieve spasm. Pounding a cramped muscle can increase soreness.

There are no proven strategies for the prevention of exercise-induced muscle cramp but regular muscle stretching pre race, adequate conditioning for the activity, mental preparation for competition through stir-up or warm-up exercise and avoiding provocative drugs may be beneficial.

Prevention – one trainer's successful experience.

The occurrence of cramp in a client's racing animal brings embarrassment as well as sympathy at the animal's plight. Here is a process that has benefitted mine.

## **Medication with non-prohibited compounds**

The greyhound market place offers dozens of fix-it products for prevention or even cure. Clients have tried many and they have failed their inferred claims. Eventually I applied human compounds that doctors recommend.

### 1. Magnesium Orotate – several brands

Orotates are mineral salts of orotic acid — used by plants and animals to make DNA and RNA. Hans Nieper, a physician and dabbler in offbeat theories of gravitation, used orotates clinically prior to 1980. He thought that orotate salts, being neutrally charged, pass easily through cell membranes. In effect, orotate ferries the mineral atoms into cells and tissues, producing higher concentrations. The supplemental dose is 1 x 400mgm tab bid, cutting back to ½tab bid when resolved. I do believe this has made a difference.

### 2. Blackmores Magnesium & Amino Acid – a powder purchasable at any health or department store. ¼teasoonful daily

3. Vitamins and Mineral tabs – I buy only human quality at regular stores and I suggest you all check the substance value provided in 1Kilo of greyhound supplements with the tighter quality control of levels found in human products. You will be surprised.

4. A word about electrolytes. – always bear in mind the trainers adage “If a little does good, more will do better”. Heavy handedness with electrolytes will create diuresis, electrolyte imbalance and increase the likelihood of cramp IMO. Remember how you feel after a feed of salty chips. I salt the evening meal a little and use a Slow K.

## **Training to prevent.**

Hand in hand with magnesium supplements has gone changes in training.

The dogs that cramped showed resentment when taken to the track as if they knew the inevitable. No more the weekly track gallops over 400 or more behind the lure but in their

place were 200 sprints at their own pace twice a day in a paddock. Within 2 weeks they were looking to return to the track and since then have not looked back.

I am not a fan of blood counts because I believe first one must establish race fit base line for individual fitness before making assumptions related to current fitness. But I would like to see a study done of blood parameters in our race dogs before and after.

Finally, the ubiquitous male animal. Both dogs affected are male, both see an essential need to water everything at a track. Surely this can be dehydrating. So one urinated on arrival, one when coming out for the race.

Clearly muscle fatigue is the major factor leading to cramp. Good conditioning is essential. Fatigue may represent inadequate training fitness or feeding, it may indicate an over-raced dog who has the appearance of fitness yet needs spelling. The only 3 dogs of mine that cramped from a kennel of 10, are all from the same litter. Others are not related but fed the same and trained similarly, don't cramp. Cramping is a conundrum really.

#### **References:**

**1. Bentley S :** Sports Med. 1996 Jun;21(6):409-20.

**2: Schwellnus MP, Derman EW, Noakes TD** Aetiology of skeletal muscle 'cramps' during exercise. J Sports Sci. 1997 Jun;15(3):277-85.

**3: Khan SI, Burne JA.** Reflex inhibition of normal cramp following electrical stimulation of the muscle tendon. J Neurophysiol. 2007 Sep;98(3):1102-7. Epub 2007 Jul 18.