# Myotonia congenita in a Jack Russell terrier

R G Lobetti[a]

**ABSTRACT**

A 4-month-old male Jack Russell terrier was evaluated for non-painful muscle spasms and collapse associated with exercise and activity. Clinical examination revealed well-defined, non-painful hypertrophic muscles of the fore and hind limbs and exercise and excitement induced hindquarter bunny-hopping gait, which improved with activity but worsened with resting and with any sudden changes in direction of movement. Neurological examination and routine laboratory testing showed no abnormalities. DNA analysis for myotonia congenita showed the dog to have a gene mutation in the chloride ion channel, diagnostic for myotonia congenita, which has not been reported in the Jack Russell terrier breed.

**Keywords:** canine, dog, muscle, congenital, DNA analysis.

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## INTRODUCTION

Myotonia refers to a state in which active contraction of a muscle persists after voluntary effort or stimulation has ceased and both congenital and acquired forms have been reported in the dog[2]. Myotonia is characterised by muscle stiffness without cramping, muscle dimpling after percussion, and characteristic electromyographic changes[10]. Myotonia congenita has been described in mice, humans, sheep, goats, horses, cats and dogs[9]. Reported affected canine breeds include the Chow, Staffordshire bull terrier, Great Dane, West Highland terrier, Samoyed, Labrador retriever, Poodle, Cocker spaniel, Ridgeback, and Miniature schnauzer[1,3,4].

Myotonia congenita has been best described in the Miniature schnauzer, in which it is inherited as an autosomal recessive trait[9] and it is believed to have a similar inheritance in the Chow[3] and Australian cattle dog[4]. A PCR-based test has been developed to detect the mutation in the Miniature schnauzer[1]. Briefly, the test extracts DNA from either blood or a cheek swab, which is then amplified around the mutation with specific primers. The 340 bp PCR product is then digested with the restriction enzyme *Hpy*CH4 III, which cuts a normal allele twice resulting in 3 fragments of 175, 135, and 30 bp, whereas the mutant allele is only cut once leaving 2 fragments of 175 and 165 bp.

The clinical signs of myotonia congenita can be improved with membrane-stabilising drugs, especially procainamide. Other drugs that have been used are carbamazepine, phenytoin, tocainide, nifedipine, and mexiletine[3]. Most dogs with myotonia congenita are not severely disabled and thus the prognosis for long-term survival is favourable[2,3].

This article reports a case of myotonia congenita in a Jack Russell terrier resulting from a spontaneous gene mutation.

## CASE HISTORY

A 4-month-old male Jack Russell terrier was referred for evaluation of a muscular problem that was characterised by muscle spasms and collapse associated with exercise and activity. The spasms were not associated with pain and had started when the dog was approximately 2 months of age. Activity, behaviour, and appetite were all within normal limits. The dog was 1 of 2 puppies from a 1st litter of the sire and dam. Clinical examination revealed well-defined non-painful muscles of the fore and hind limbs that were bordering on hypertrophy and exercise and excitement induced hindquarter bunny-hopping gait, which improved with activity but worsened with resting and with any sudden changes in direction of movement. No dimpling of the appendicular muscles was noted after percussion. Neurological examination, full blood count, serum creatine phosphokinase activity, and serum electrolytes were all within normal limits. An EDTA blood sample and a buccal cheek swab were submitted for DNA analysis for myotonia congenita (Josephine Deubler Genetic Testing Laboratory, University of Pennsylvania, School of Veterinary Medicine, Philadelphia, USA), which showed the dog to have the *ClC-1* gene mutation, diagnostic for myotonia congenita. Subsequent to the diagnosis, buccal cheek swabs were submitted from the dam, sire and the other sibling, a female. All 3 were clear for the gene mutation. The dam, sire and the other sibling showed no clinical signs of myotonia.

In summary, the history, clinical findings, and DNA analysis were consistent with myotonia congentia, which to the author's knowledge has not been reported in the Jack Russell terrier breed. Therapy with either procainamide or mexiletine was not used as the condition was non-painful and was not affecting the apparent quality of life of the animal. On subsequent telephonic reports the owner reported that the condition of the dog has remained static.

## DISCUSSION

Clinical signs associated with myotonia congenita are difficulty in getting up after a period of rest; stiff and stilted gait when walking, which improves after walking for a while; bunny-hopping when running; muscle stiffness with any rapid change in posture, and non-painful muscle hypertrophy, mainly the proximal limb and axial muscles[2,10]. These reported clinical findings were present in this Jack Russell terrier. Percussion of the muscles and tongue may leave an indentation, referred to as a 'myotonic dimple'. Unlike other breeds, no dimpling of the appendicular muscles was noted after percussion. Complete blood counts, serum biochemistry, and serum creatine phosphokinase show no consistent abnormalities[10]. Characteristic findings on EMG for myotonia congenita are bizarre high-frequency discharges that wax and wane[3]. These discharges are frequently referred to as 'dive-bombers'. Unlike other species affected with myotonia congenita, the Miniature schnauzer shows dental and craniofacial abnormalities[10]. At presentation this Jack Russell terrier did not have any craniofacial abnormalities and to date has not developed any. Facial deformities were also not reported in the Australian cattle dog[4]. Thus it would appear that

[a]Bryanston Veterinary Hospital, PO Box 67092, Bryanston, 2021 South Africa. E-mail: rlobetti@mweb.co.za

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craniofacial deformities with myotonia congenita are only associated with the Schnauzer breed.

Similar conditions to myotonia congenita in the Jack Russell terrier would be hereditary ataxia and myokymia. Hereditary ataxia in the Jack Russell terrier is characterised by a gait disturbance with symmetric generalised ataxia and hypermetric and spastic movements. Gait abnormalities usually start at 2–9 months and some dogs develop generalised seizures. Histopathology shows an axonopathy of the entire central nervous system[11]. Myokymia is a condition where there is episodic continuous muscle fibre activity, resulting in muscle stiffness, delayed muscle relaxation and often associated with collapse into lateral recumbency. Affected animals show progressive ataxia and have intermittent episodes of rhythmic undulating muscle movement[7]. The dog in this report did not show clinical signs typical for either hereditary ataxia or myokymia and was positive for myotonia congenita on DNA analysis.

Myotonia congenita results from a genetic defect in the skeletal muscle chloride ion channel (*ClC-1*)[5], which causes a biochemical defect of reduced chloride conductance across the skeletal muscle membrane that increases sarcolemmal excitability[8]. A link between myotonia and chloride conduction was first made in myotonic goats and latter in humans[4]. The molecular defect is a missense mutation resulting in a C to T transition in the *ClC-1* allele predicting the replacement of a threonine residue (ACG codon) by methionine (ATG codon)[1]. In humans, mutations in the *ClC-1* gene have been reported in isolated families. Twenty-two mutations cause the autosomal recessive form of myotonia congenita (Becker type) and 7 mutations cause the dominant form (Thompson type)[4,5]. Mutations in the *CIC-1* gene have been identified in the mouse, 'fainting' goats, Miniature schnauzer, and the Australian cattle dog[4]. Miniature schnauzers and the Australian cattle dog showing myotonia congenita are homozygous for the gene mutation[1,4]. The mutant allele can be spread in a population by breeding carrier dogs, as clinically normal parents of myotonic dogs must be obligate carriers and can only be determined by DNA testing or by test mating.

In the Miniature schnauzer it would appear that myotonia congenita originated from 1 common male ancestor, which was a carrier and used for breeding as it was a champion male. In a similar way the disease could have become established in the Jack Russell terrier breed if the dog in this report went on to mate and spread the mutant allele. As only 1 dog was affected and no gene defect was present in either the sire or dam, it would appear that this dog showed a spontaneous mutation in the *ClC-1* gene. To prevent the mutation from spreading within the breed, castration was strongly recommended.

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