

# Llama Failure to Thrive Syndrome

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The llama (*Lama glama*) presents today's veterinarian with all the difficulties and medical uncertainties of treating a new species. Both the rapid increase in their numbers in the United States, and their relatively high monetary values have contributed to their recent significance in veterinary medicine. Complexities encountered by the veterinarian begin with llama anatomy and physiology, both of which are somewhat different from what is seen in common domestic species such as the equine, bovine, or ovine. Thus, it is not surprising that some llama diseases present uniquely and are poorly understood and researched at this time. An important condition which belongs in this category is the failure to thrive syndrome of llamas (FTS).

Generally, FTS llamas are born clinically normal and remain so throughout the first six months of life (or until weaned) at which time they may display unthriftiness, stunting, or weight loss.<sup>1</sup> Almost all of these animals die before three years of age. Parasitism, malnutrition, and orodontal problems may be underlying causes in some llamas and should be ruled out early in the course of the disease.<sup>2</sup> In addition, immunodeficiencies which result in repeated, low-grade bacterial infections that healthy animals normally resist, seem to be one of the more common problems encountered. The relationship of any of these diseases to each other is unclear, however, and underlying etiologies are difficult to determine. Evidence for a genetic component to the syndrome does exist.<sup>2,3</sup>

Currently, there are virtually no published research articles on FTS and very few literature references. This paper will review one published article and compare clinical cases of FTS in llamas seen at the Iowa State University Veterinary Teaching Hospital.

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Researchers led by Bradford B. Smith<sup>2</sup> at Oregon State University reported on a collection of medical problems in twenty-three underweight llamas examined over a three year period. Parasitism was ruled out as a primary problem, and no geographical correlation to incidence was found. Of the twenty-three llamas, eight were anemic, hypothyroid, and had abnormal erythrocyte morphology (marked anisocytosis, poikilocytosis, and intracytoplasmic clumping of hemoglobin). Most of these llamas had died by three years of age. Two additional animals had transitory erythrocyte changes and were euthyroid. The remaining llamas were not anemic; eight were euthyroid with small body sizes and moderate to severe ALD, and four were classified as only marginally hypothyroid. Seven of the twenty-three llamas were hypophosphatemic.

Four of the hypothyroid llamas were given a thyroid supplement orally; however, despite T4 and T3 values rising to near normal, no clinical improvement was seen. Histologically, the thyroid glands evidenced degeneration and follicular atrophy. Some of the llamas with normal thyroid function, however, had similar histologic changes. Hypothyroid llamas were different only in the "tinctorial properties of the colloid and clusters of degenerate, disorganized follicles." The animals were hypo-responsive to thyrotropin administration, indicating a possible primary hypothyroidism, but hormonal replacement failed to stimulate the expected erythropoietic activity.

Six of the llamas were given oral iron supplementation which resulted in inconsistent packed cell volume (PCV) increases. The researchers attributed this to failure of intestinal absorption and used injectable iron supplementation in a seventh animal. This animal also developed an increased PCV (>40%) as well as dyscrasia resolution after six months of bi-monthly treatments.

In Smith's study, three of the affected animals were full sisters. The researchers also discovered that "a small number of males were repeatedly found to be sire, grandsire, or great-grandsire of all affected animals." Although the

genealogies were incomplete, the trait did not appear to be sex-linked.

At Iowa State University Veterinary Teaching Hospital (ISU VTH), the primary focus of FTS is on immune dysfunction rather than anemic and underweight characteristics addressed by the Smith group. FTS llamas at ISU VTH are characterized as weaned llamas greater than six months of age, with immunoglobulin levels persistently low (IgG < 500 mg/dl), and a repeated subjection to low-grade bacterial infections that would not normally cause a problem in the healthy animal. Normal adult llama IgG levels have been measured at 800 to 1,000 mg/dl.<sup>4</sup>

Over a two-year period, nine llamas (three males and six females), ranging from six to thirty months of age, presented to ISU VTH. All seven of the llamas whose IgG levels were measured by serum electrophoresis showed significantly decreased levels. When these llamas' weights were compared to Smith's graph of normal llama weight versus age ranges<sup>2</sup>, three had average, two heavier, and one lighter than normal body weights. Eight of the nine llamas eventually died (all less than three years of age) and were necropsied at ISU VTH. Five llamas died with fulminating septicemias. Unlike at Oregon State University, researchers at ISU VTH did not measure T4/T3 levels, response to thyrotropin administration, or serum iron concentration.

Llama 1 presented to ISU VTH as a neonate with a history of failure of passive transfer. This was diagnosed by IgG levels of 95 mg/dl at greater than twenty-four hours of age. She was treated symptomatically and discharged. She re-presented at nine months of age with a history of heat stress and complaints of nasal discharge and anorexia. She had a normal body weight for her age. IgG levels measured 144 mg/dl. She died of acute respiratory distress, and necropsy revealed severe fibrinous peritonitis with adhesions and caudal lung consolidation. Intranuclear inclusion bodies in lesions of the gastrointestinal tract and associated with vasculitis were suggestive of a DNA virus, but no agent was identified. No histologic signs of lymphoid depletion were present. *Pseudomonas aeruginosa* was recovered from the lungs.

Llama 2 presented at twelve months of age with complaints of oculonasal discharge and diarrhea. She was diagnosed with nongranulomatous uveitis and mild pneumonia.

She presented two weeks later with pneumonia. At that time, her IgG level measured 23 mg/dl. At two, five, and six weeks during her hospital stay, IgG levels measured twelve, ninety-six, and 110 mg/dl, respectively. She was within the normal body weight range. Llama 2 was still alive and clinically normal at the time of this writing, at twenty-four months of age.

Llama 3 presented at two years of age with a history of heat stress and complaints of oculonasal discharge and anorexia. He was above the normal weight range for his age, but had an IgG level of 85 mg/dl. *Pseudomonas aeruginosa* was isolated from a blood culture. He was diagnosed as being hyposelenemic and hypoproteinemic. At necropsy a fibrinous peritonitis, pleuritis, and pericarditis was found. Histology of lymphoid tissue demonstrated hypocellularity without secondary centers of follicular development.

Llama 4 presented at eight months of age with the complaint of being sick and lame. She was above average weight. She died and necropsy revealed septic arthritis, pleuritis, and peritonitis. *Pseudomonas aeruginosa* was isolated from blood and affected joints. Histologically, lymph nodes revealed lymphoid atrophy. No IgG levels were obtained on this animal.

Llama 5 presented with a fever and a nasal discharge at about twelve months of age. She had normal body mass. Her IgG levels measured 212 and 182 mg/dl (samples taken one week apart). She was treated for a *Pasteurella hemolytica* pneumonia and released. She presented two weeks later with a nasal discharge. IgG levels measured 426 mg/dl. A culture from a tracheal wash produced *Streptococcus* and *Fusobacterium*. Her pneumonia was treated and she was released. She presented five months later and IgG levels measured 800 mg/dl. She died and necropsy revealed a severe, acute, diffuse polyserositis. Large numbers of pure cultures of type B *Salmonella* were cultured from pleural fluid, lung, liver, spleen, and abdominal fluid. Both lymph node and spleen histologically showed lymphoid depletion.

Llama 6 presented at six months of age with diarrhea. He was severely dehydrated and died shortly after admission. He had a severely swollen left hind leg with an unstable hock and stifle. Necropsy revealed pleuritis, congested lungs, and a fulminating septicemia due to *Pseudomonas aeruginosa*, which was

cultured from blood, pleural and peritoneal fluids, and feces. He had mild lymphoid depletion of the spleen. IgG levels and a weight were not obtained on this animal.

Llama 7 presented at about thirty months of age with glaucoma and a fever. She was diagnosed as having panophthalmitis and a detached retina. *Klebsiella oxytoca* was isolated from intraocular fluid. She had IgG levels of 60 and 140 mg/dl (one week apart). Her body weight was in the normal range. This llama was euthanized. Histologic evaluation of lymphoid tissue was not available.

Llama 8 presented at fifteen months of age, febrile and down. She was diagnosed as having acute heat stress, hypophosphatemia, and hypomagnesemia. She had an IgG level of 99 mg/dl. She died two days later with a severe, acute, fulminating pneumonia. Histology revealed moderate lymphoid depletion in the spleen.

Llama 9 presented at about thirty-six months of age with complaints of anorexia, chronic weight loss, and nasal discharge. He was diagnosed as having diarrhea, anemia, eperythrozoonoses, leukopenia, hypoproteinemia, and hypoalbuminemia. He had an IgG level of 125 mg/dl. He was euthanized, and necropsy revealed hepatitis with fatty changes and moderate to severe lymphoid depletion.

### Dicussion

This brief examination of nine FTS cases seen at ISU VTH did not include all of the FTS cases seen during the two-year period. In the past year, fifty-four llamas have presented to ISU VTH, of which nine were diagnosed as having FTS.

This study did not see the underweight llamas reported by Smith<sup>2</sup>. On presentation, three llamas were heavier than normal for their ages, three were of average weight, and one was underweight. Llama 9, who was in the normal weight range of 100 kg at thirty-six months of age, was experiencing severe, chronic weight loss.

Eight of the llamas died at an average age of 18.6 months (median age of fifteen months, range of six to thirty-six months). This compares favorably to the median age of death, 13.2 months (range of 9.4 to 29.3 months)<sup>1</sup>, in another study. Llama 2, at the time of this writing, was still alive and clinically normal at twenty-four months of age.

The immunoglobulin levels measured in seven llamas were strikingly low. Hyperglobulinemia is expected with chronic infections, and this condition was not seen in any of the animals. The average IgG level for this group of llamas was 172 mg/dl (range 35 - 800 mg/dl). These values, coupled with the varying amounts of hypocellular lymphoid tissue in six llamas, provide evidence of immune dysfunction, which in turn may explain the repeated bacterial infections producing diarrhea (llamas 2, 6, 9), pneumonia and upper respiratory tract infections (llamas 1, 2, 3, 5, 8, 9), and arthritis (llamas 4, 6). Llamas 1, 3, 4, and 6 had fulminating septicemia due to *Pseudomonas aeruginosa*, and llama 5 had a type B *Salmonella* septicemia. Furthermore, studies have shown that eperythrozoonosis in llamas affects mainly young llamas with stressed immune systems such as seen in llama 9.<sup>5,6</sup> Additional data to note is that llama 1 had evidence of an unidentified DNA virus and llamas 1, 2, 4, and 5 had either the same sire or grandsire.

An underlying etiology for FTS in llamas is not clearly seen in this study. When the veterinarian is faced with diagnosing a case of FTS it is important to first rule out other possible causes such as parasitism, malnutrition, or orodontal problems. Next, blood and serum chemistry panels should be obtained, with special attention directed at possible *Eperythrozoon*-like organisms and serum phosphate levels. Additionally, serum should be collected for determination of immunoglobulin levels at two week intervals. Persistent IgG levels less than 500 mg/dl are suggestive of FTS. Opportunities to do lymphocyte blastogenesis assays should be taken, as this will provide additional evaluation of immune function.<sup>1</sup> A history of repeated bacterial infections with a response to aggressive antibiotic therapy followed by relapse is also suggestive of FTS. If the llama should die, in addition to routine bacterial culture of multiple organ systems, a fungal culture from the lungs should be attempted; mycotic infections are common in immunosuppressed animals.<sup>1</sup> Finally, lymphoid tissues should be examined histologically for evidence of atrophy void of secondary follicular regeneration. The prognosis for FTS llamas is very poor as few live beyond three years of age.

The most important thing to remember about FTS in llamas is that it is not a definitive diagnosis but is simply a syndrome defining an

animal's condition. Numerous causes have been incited. The anemia, low weight, low serum iron, and low serum T4/T3 levels in the llamas seen by Smith may have been signs unrelated to the syndrome seen at Iowa State University. The primary identifying characteristic of the llamas seen at ISU VTH was immunodeficiency.

### References

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"Meatball"--Merill Guarneri