

# Calcium and Birds

**Neil Forbes FRCVS and Petra Zsivanovits MRCVS describe the benefits and problems of calcium in psittacine birds**

One and a half per cent of a bird's body weight is made up of calcium, which represents the most predominant mineral in the body.

## Physiological functions

Calcium is involved in blood coagulation, transmission of nerve impulses, the permeability of cell membranes, activation of enzyme systems, glandular secretion, muscle contraction, calcification of eggshells and contraction of the uterus during egg-laying.

When considering normal blood calcium levels, one should first consider what is really 'normal' for that species. There is an argument that the normal blood values of a given species are those extracted from free-flying individuals, living in their natural environment, given the freedom to feed and exercise as nature alone dictates.

But can we really expect our caged feathered friends' blood to match up to their wild cousins? So many caged birds are fed such a poor diet (often for a period of decades), that so called 'normal' values may well include values which were in fact from birds on a long term deficient diet. The consequence of this is that one includes into a normal range, the values for birds which are actually far from normal.

Over 95 per cent of eggshell is composed of calcium carbonate. When considering blood calcium levels it is important to remember that lipaemia (fat

in the blood) can falsely elevate blood calcium levels. Additionally, increased calcium concentrations have been reported with dietary excesses of vitamin D<sub>3</sub>, osteolytic bone tumours and dehydration.



*Bowing of the legs and wings in a deficient bird*

Calcium is absorbed in the upper small intestine. It then enters the mucosal membranes (lining of the gut wall) and is then secreted into the blood. The absorption is increased by high-protein diets and acidification of the intestines while components such as phytate (in cereal grains), oxalates (in spinach, rhubarb and related vegetation) and phosphates (high in pulses and meat) decrease absorption of calcium due to formation of complexes.



*Severe bending of the tibiotarsus due to rickets*



*Kyphosis of the spine – often linked to calcium deficiency*

Insoluble calcium salts are formed in the presence of high concentrations of free fatty acids (often found in very high-fat diets such as sunflower or peanut based diets). Additionally, calcium is 'recycled' in the avian kidney.

## Parathyroid hormone

Calcium metabolism is predominantly regulated by two hormones and one vitamin that closely interact with each other. Parathyroid hormone is secreted in response to a lowered blood calcium level.

Not only does parathyroid hormone increase the blood calcium level but it also influences the secretion of phosphate from the kidney, thereby decreasing the blood phosphate level. This is important as the metabolism of calcium:phosphorus:Vitamin D<sub>3</sub> are all inextricably linked. Although one may refer to a bird as being calcium deficient, in reality it is an imbalance of Ca:P:D<sub>3</sub>.

Prior to egg-laying additional bone is laid down in the middle of the upper leg and wing bones (medullary bone) forming a reserve to be called upon at this time of exceptional calcium requirement. During the egg-laying cycle, parathyroid hormone controls the reabsorption of this medullary bone to meet the raised calcium requirements of eggshell production.

Field experience with formulated diets suggests that approximately one per cent calcium in dietary dry matter is sufficient for reproduction in psittacine



*A calcium deficient diet*

birds. Indeed if there is more than one per cent dietary calcium, eggshells maybe excessively thick, which may lead to reduced weight (water) loss during incubation and hatching difficulties.

It is evident that carnivorous birds fed an all-meat diet (rather than a mixed meat and bone, (i.e. whole carcass diet) are particularly at risk, but so also are psittacines fed on seed based diets with poor Ca:P ratios.

### Malnutrition

Birds fed on unbalanced diets typically suffer from malnutrition, leading to diseases such as mouth or respiratory infections, central nervous signs (e.g. seizures, fits or weakness). As pointed out above, diets that contain predominantly seeds are deficient in calcium.

Strangely many pet parrot owners when questioned in the surgery as to their bird's diet, proudly exclaim they are on a 'premium' diet. This typically comprises sunflower seeds with added dried fruit, chilli peppers etc. However when you question the same owner as to what the bird actually eats, (rather than what it is offered), the response is usually 'just the sunflower seed'. On occasions the owner qualifies the diet eaten by stating that the bird also eats lots of fruit and vegetables. However when one considers that seed is at least 90 per cent dry matter, while fruit and vegetable is 85-90 per cent water, the bird would actually need to eat six to nine times the volume of fruit or vegetable as seed for them to consume the same amount of each food type in comparable dry matter terms.

Fruits and most vegetables also have a low calcium content. Most seed diets contain excessive levels of fat and may be deficient in certain vitamins, minerals, trace elements and some essential amino acids. Studies about the composition of seeds with and without hull show that the calcium content is halved when the hulls are removed.

Calcium supplementation can be offered in form of calcium syrup or powder. Any supplement added as a coating to the outside of seed is largely lost when hulls are removed and powdered supplements commonly separate from the food that is eaten if the food is not moistened. Food with naturally high levels of calcium are bone, cheese or yoghurt.

### Grit and crushed shells

There is a difference between grit and crushed shells. Grit is composed of minute stones and commonly contains silicate and sandstone. Crushed shell is almost entirely composed of limestone (calcium carbonate) and is readily digested by acids in the proventriculus. Therefore, crushed shells provide a source of calcium, while grit's main effect is in aiding the mechanical breakdown of dietary plant material. We now know that grit taken up as a youngster will last birds for years and no further grit is required.



Significant bowing of the legs and wings of a ricketic bird

### Physiological Phenomena

During the reproductive cycle there are physiological phenomena, which are related to changes in calcium metabolism.

A few days before ovulating, calcium blood levels can increase in psittacine birds and this increase, with deposition in the medulla of thigh and upper wing bones (femur and humerus) will occur even when birds are on a calcium deficient diet.



Good fresh food

Reproductively active psittacines have a selective preference for foods rich in calcium. Their consumption of calcium increases daily during the pre-laying and during the early stages of shell calcification, so long of course as they can gain access to additional dietary calcium. Furthermore, renal calcium excretion decreases during shell formation.

### Medullary bone

The medullary bone fills the cavity of long bones, and the skeleton may increase in weight by up to 25 per cent during the pre-laying period. These bone changes are readily evident on radiography at this stage of the reproductive cycle. The calcium is later reabsorbed and deposited in the eggshell as calcium carbonate, each egg using nearly 10 per cent or more of total body calcium.

Approximately 30-40 per cent of eggshell calcium is derived from medullary bone, if calcium concentration in the food is below two per cent. Conversely if the dietary calcium concentration is 3.6 per cent the entire calcium demands can be provided from intestinal absorption..

As much of the eggshell is formed during the night, when generally no calcium is consumed and when the calcium content of the digestive tract is gradually decreasing, medullary bone may be considered as the primary source of shell calcium. It doesn't take a rocket scientist to calculate the possible effects of repeated egg-laying by a hen which is on a deficient diet. In time either her skeleton will become depleted or she will lay calcium deficient eggs (leading to deficient chicks at hatching) or both.

### Pathological conditions

In contrast to the physiological phenomena described above there are several pathological conditions which influence or cause 'hypercalcaemia' (excess blood calcium) or 'hypocalcaemia' (deficiency of blood calcium).

In male and non-laying female budgerigars, a phenomenon can occur which resembles 'physiologic bone marrow ossification', but involves mainly humerus and femur in budgerigars. The birds can show apathy, in-coordination, increased thirst and urination, abdominal distension, weakness, paralysis of one or both legs. Impaired liver function (often linked to a high fat diet - >>>



Three 'greenstick' fractures in a young calcium deficient bird

e.g. sunflower, peanut or millet – causing a fatty liver condition) has been suggested as a possible reason as the liver is responsible for removing oestrogens from the blood.

Many problems that arise in 'hatching' psittacine chicks can be related to calcium imbalance. Female birds, which are deficient in vitamin D<sub>3</sub> or calcium, can lay soft-shelled or thin-shelled eggs that are more prone to cracking during incubation. Malnutrition during the neonatal rearing period is a particular risk. While many adult birds will cope with a marginally deficient diet, a young fast growing chick will certainly be affected. Orthopaedic problems such as leg deformities and toe mal-position are most commonly caused by nutritional deficiencies during the rearing period (especially of vitamin D<sub>3</sub> and calcium). Indeed these are the problems which we most commonly experience in practice.

### Hypocalcaemia

Secondary nutritional hyperparathyroidism occurs as a result of a calcium-deficient diet and has been reported as a common problem in birds. In this condition there is only a limited absorption of calcium from the diet, leading to an increase in parathyroid gland size as it attempts to maintain normal blood calcium levels. As stated before it is the Ca:P:Vit D<sub>3</sub> ratio which is all important, rather than the calcium alone.

Clinical signs include hypocalcaemia (low blood calcium), frequently leading to seizures, weakness, muscle cramps, increased thirst, loss of appetite, regurgitation, decreased egg production, production of soft-shelled

eggs, egg binding and fragile (brittle) bones leading to pathologic fractures.

### Bone disease

Metabolic bone disease in birds occurs as two forms: rickets which is found in growing animals, while osteomalacia (osteodystrophy) occurs in mature birds. Rickets is characterised by an inadequate dietary intake of calcium, phosphorous and vitamin D<sub>3</sub> or improper calcium to phosphorous ratio, which results in an enlargement of the parathyroid glands. The result is that the bones, which grow by way of cartilagenous extensions of the long bones, fail to mineralise.

The disease is most commonly seen in hand-reared psittacine birds. Bone deformities develop throughout the skeleton, and affected nestlings are often found in a characteristic sitting position with spread legs. The skeletal bones and beak become soft and pliable. The deformation of the ribs can lead to breathing distress.

### Osteomalacia

Birds that are effected by osteomalacia show enlarged parathyroid glands and hence have an increased osteoclastic activity (i.e. the bird is breaking down more of its own bone in an attempt to maintain an adequate blood calcium level), this can result in complete demineralisation of medullary bone, then progressing to affect cortical bone in severe cases. As bones become more demineralised, spontaneous fractures occur. These fractures affect demineralised bones with thin cortices (the outer wall of the bone) and are termed 'greenstick fractures' because these bones are soft and bendable, flexing and resetting in a manner similar to a green twig on a tree.

### African Grey parrots

In raptors and particularly in African grey parrots in the age range two to five years, a so-called hypocalcaemia syndrome has been described. Clinical signs are in-coordination, imbalance (such as falling off the perch – often interpreted as weakness), convulsions and seizures. Indeed this is the commonest cause of central nervous disease in African grey parrots. The bird is often hypersensitive to noise or movement. Notable is the fact that in African grey parrots there is no demineralisation of the skeleton to

maintain normal calcium levels. Affected birds typically respond within minutes of treatment.

Research has shown that African grey parrots have significantly lower calcium, albumin and total protein concentrations compared to Amazon parrots, which may account for why they are the species most commonly affected by this condition. There are theories postulated that these birds are not able to mobilise body bone calcium stores (which indeed would be the case if insufficient parathyroid hormone was being produced). Vitamin A deficiency may also play a role as this inhibits osteoclast activity and hence prevents mobilisation of calcium from bone. The condition has also been described in Amazon parrots and conures.



Bent ricketic legs not treated as a youngster leading to severe arthritis and joint collapse at six years of age

### Conures

Erythremic myelosis in conures (Haemorrhagic conure syndrome) occurs from a combination of calcium deficiencies together with dietary lack of vitamin K and other nutrients. They are believed to trigger the disease by possibly altering normal clotting mechanisms. Nose bleeds, breathing difficulties, severe weakness, intermittent increase in urination and diarrhoea are possible clinical signs. Blood biochemistry shows decreased total protein and blood calcium deficiency. Administration of calcium can prolong a bird's life and may stabilise the patient's condition.

## Hypercalcaemia / hypervitaminosis D<sub>3</sub>

An intake of more than three per cent of dietary calcium can lead to hypercalcaemia especially when linked to high vitamin D intake, which causes abnormal calcification of the kidney tubules and arteries as well as calcium deposition in and around the internal organs.

Cockatiels seem to be particularly sensitive to high calcium and/or vitamin D<sub>3</sub> levels in the diet. Young macaws may also be more susceptible to this. Conversely signs of vitamin D<sub>3</sub> deficiency parallel those of calcium deficiency, as each causes failure of the same calcium metabolism system. Adult females may show thin or soft-shelled eggs, decreased egg production and poor hatchability. Seizuring or leg weakness may occur due to pathologic bone fractures.

In neonates, fractures and bent bones are particularly common. Low levels of calcium in the diet, particularly if associated with high levels of phosphorous (as found in meat, pulses, brazil and peanuts, pumpkin seeds, safflower, sunflower) will precipitate the clinical signs associated with hypovitaminosis D<sub>3</sub>.

## Ultra-violet light

Ultra-violet light is provided with full spectrum lighting or by natural unfiltered sunlight. Evidently parrots were designed to live in a natural outdoor situation and not enclosed away from the sunlight.

## Gout

Gout is the deposition of uric acid crystals on body organs (visceral gout), in joints (articular gout) or in the ureters (renal constipation). High dietary levels of protein, calcium, hypervitaminosis D<sub>3</sub>, poor kidney response, dehydration, cold weather and other stress factors work together to interfere with the kidney's ability to adequately excrete uric acid.

## Feathers and skin

Deficiencies of minerals such as calcium, zinc, selenium, manganese and magnesium may be associated with brittle, frayed feathers and itchy skin. There may be alterations in colour or the plumage can appear dull with a lack of sheen. Symmetric feather loss and moulting disorders can occur.

Another condition that occurs in fast growing larger waterfowl is the rotation of the distal wing tip (beyond the carpus – i.e. wrist) due to heavy, blood-filled,

developing flight feathers being supported by non-rigid growing bones. The result is that the primary flight feathers stick out when the wing is folded at rest to the body (giving rise to the colloquial term 'angle wing' or 'airplane wing'). Contributing factors may be of genetic origin or related to incubation and hatching problems or malnutrition. Rapid growth due to excessive levels of protein and energy and low levels of calcium, calcium and phosphorous imbalance, and hypovitaminosis D<sub>3</sub> may all interact. The condition has also been described in some psittacine birds such as budgerigars, macaws, and conures.



A GP fitting with hypocalcaemia

## Practical consequences

Whenever possible allow parrots access to unfiltered daylight (at least 45 minutes each day), or alternatively provide UV light by means of full spectrum bulbs, to be changed every 6 months and not to be placed more than 1 metre above the perching position.

A correct dietary calcium-to-phosphorus ratio (1.5:1 to 2:1) is essential. Foods high in phosphorus should be minimised (i.e. meat, pulses, brazil and peanuts, pumpkin seeds, safflower, sunflower). Foods with a correct Ca:P ratio should be encouraged (blackberries, citrus fruits).

While there may be some controversy about allowing parrots to eat (well cooked) chicken bones, it certainly is beneficial from a calcium metabolism point of view. I would suggest that parrots be offered one well cooked chicken drumstick with all meat removed, once a month. Such bones should be hung up to prevent them from swallowing the whole bone, but so that they can bite the soft parts from around the joint. Unless a high quality pelleted diet is fed, it is almost certain that you will need to provide a Calcium plus vitamin D<sub>3</sub> supplement.

The provision of adequate levels of Vitamin A is important not only for calcium metabolism but also for the prevention of

respiratory and mouth infections. Vitamin A is found at high levels in the following foods (in the level of decreasing concentration): apricot, tomato, peach, pumpkin, plum, carrot, red peppers, sweetcorn, citrus fruit, green peppers).

Food supplements can be excellent if they are actually consumed at the manufacturers recommended level. Keepers should never use more than one supplement, as over supplementation can certainly cause significant disease.

Years ago a survey was conducted which demonstrated that 75 per cent of all sick parrots were suffering from a nutritional deficiency which was in part responsible for their disease condition, sadly little has changed.

As eloquently described by Rosemary Low in *Parrots* Issue 44, a diet should be varied and balanced. This may be achieved by feeding some seeds, together with sprouted seeds and fresh fruit and vegetables. Even the latter diet does require the addition of a suitable vitamin and mineral supplement. Such diets need to be prepared fresh daily with particular attention to hygiene. This is certainly my preferred method for



A quality compound diet

parrot breeders or enthusiasts with numbers of parrots who are able to spend a considerable amount of time about their birds on a daily basis.

However, breeders not only have the time to prepare a mixed soft food diet, but also they have many mouths to feed. The cost factor alone is the reason why few parrot breeders feed a pelleted diet. However for the average pet parrot owner, making a fresh wet diet daily is equally impractical. The cost of feeding a pelleted diet for a single bird is a small price to pay for a healthy bird. There is no reason why a pelleted diet should not be supplemented with fruit or vegetables.

There is no doubt that some makes of pelleted diet are more palatable and hence readily accepted by some species than others. No one is suggesting that this is always an easy task. Birds accustomed to a sunflower or peanut based diet do actually become addicted to it, (conversion from burgers and chips to fresh salad and fruit is not always easy). ■

