Improving Bone Density - Building Stronger Bones

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Fifty five million years of evolution has seen the horse develop from a small, dog sized creature with four toes on each leg into the tall, elegant, fleet-footed animal we know today. The requirement for speed as a means of eluding predators has lead to unique skeletal adaptations. Compared to most grazing animals a horse's legs are disproportionately long and light. By keeping the heavy muscle mass at the base or pivot of the limb, the leg is able to swing like a pendulum. The net result is a relatively small amount of muscular effort at the shoulder and hip results in a large range of motion at the foot. This energy efficient apparatus allows the horse to maintain high speeds over longer distances compared to other mammals.

The necessity for the bones to be light enough to be transported efficiently without wasting energy has to be offset against the need for strength and rigidity – after all, structural support is the most important role of the skeleton. The long bones of the distal limbs have unique design features that allows them to effectively resist the upwards forces of impact and loading and the opposing downward forces of the horse's own bodyweight. The hoof mechanism, tendons, muscles and ligaments help in this role.

To understand what happens to the forces of impact, it is helpful to study the stride during motion. Each stride can be divided into 2 parts; the contact phase when the foot is on the ground and the swing phase when it is off.

The contact phase can be further subdivided into (fig 1);

- impact phase
- loading phase
- break-over phase

The impact phase occurs during the first few milliseconds after the hoof contacts the ground. During this phase the limb undergoes rapid deceleration. This sends a force as a series of waves through the limb which are initially absorbed by the hoof mechanism, followed by the bones and joints. Not surprisingly it is during this phase that most bone and joint injuries occur.

The loading phase follows the impact phase. As the horse's weight passes over the stationary hoof, the tendons and ligaments undergo maximum loading. Their inherent elasticity enables them to absorb the loading forces. Most tendon and ligament injuries occur during the loading phase.

The break-over phase begins when the heel of the foot leaves the ground and begins to rotate around the toe which is still in contact. Break over at the centre of the toe begins the swing phase of the stride. The forces on the limb during the swing phase are minimal.

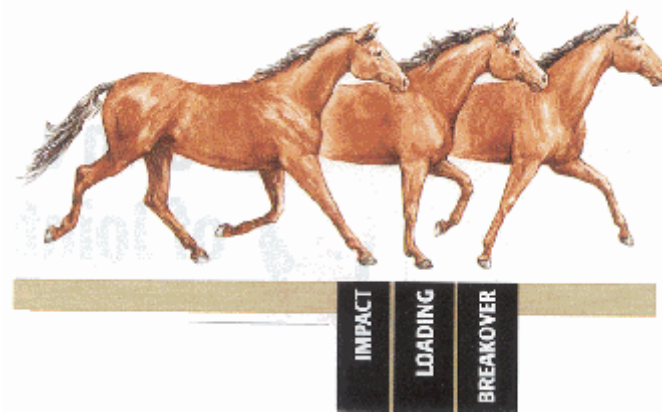

Fig 1: Contact Phase of the Stride.

Speed, conformation, hoof balance and track surface all have an effect on the magnitude and distribution of the impact and loading forces.

Speed has the greatest effect; remember the equation *force = mass x acceleration*? Obviously mass or weight remains constant during exercise but the faster a horse accelerates, the faster the limb decelerates at impact. Consequently the forces absorbed by the bones and joints increase. A horse travelling at race speeds is subjected to forces equivalent to three times its bodyweight.

Conformation and hoof balance play an important part as to how the forces are absorbed. Correct alignment of the bones and joints in relation to the foot and to each other are necessary to avoid uneven distribution. The foot has a 'centre of gravity' as does the limb as a whole. Ideally both should be directly in line with each other and joined by a straight column of bones.

A good track surface should have a natural 'springiness' that matches the stride. During the impact phase the surface should give slightly (a galloping horse should leave a surface impression approximately 50mm deep). It should start to rebound half way through the loading phase and reach full rebound at the start of the break-over phase. In this way the track works in unison with the stride. A surface that is too hard rebounds too quickly during the loading phase which adds to the forces on the limb. If the surface is too soft it will rebound too late to be of any benefit in reducing impact.

Serious bone injuries are generally attributed to normal bone reacting to abnormal circumstances, the so called 'bad step' on the track. Using the latest bone scanning technology, equine researchers have been able to show that this is often not the case. Most serious bone injuries are in fact caused through abnormal bone reacting to normal impact and loading. Many apparently sound horses are in fact unsound – they have areas of weakened bone along with small stress fractures that predispose to more serious injuries.

Bone is a dynamic tissue, constantly remodeling itself in response to the forces of impact and loading. Bones are made up of two types of bone tissue (fig 2). Cortical bone is the dense bone that gives bones their shape and strength. It makes up 80% of the adult skeleton. Trabecular bone is the 'mesh like' or honeycomb bone that forms in

Dietary mineral supplementation along with careful design of training programmes will result in improved bone density and in turn, improved skeletal durability. Young horses will able to stay in training for longer without the interruptions that bone injuries can cause.

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