What do markers of bone formation tell us in equine nutritional studies?

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Introduction

Skeletal injuries in performance horses are quite common. Research investigating ways to decrease injuries has been limited due to difficulty in non-invasively measuring the response of bone to a given treatment. With the use of biochemical markers of bone turnover, more projects are being conducted and advancements in improving bone health are occurring. However, such assays are expensive and researchers often need to make decisions as to when their use is justified. By reviewing the responses of bone markers in nutritional studies and comparing them to responses in exercise studies, the objective is to determine whether bone is more likely to respond to a dietary or exercise treatment.

Materials and methods

The results of studies using the marker of bone formation - osteocalcin (OC), as well as markers of bone resorption - pyridinoline and deoxypyridinoline crosslinks (DPD) and carboxy-terminal pyridinoline cross-linked telopeptides of type I collagen (ICTP), were compiled and summarized.

Results

Of seven nutritional studies using OC concentrations to examine dietary impacts on bone, five showed no differences while two reported a trend for differences (Table 1). Of three

Table 1 Studies evaluating markers of bone metabolism in response to alterations in nutrition or exercise.

Nutritional Study	Parameter altered	OC	DPD	ICTP	Bone Quality
Nielsen 1998	Ca, P	No			T
Fenton 1999	Glucosamine	No			
Lang 2001a	Supplemental Si	T	T	No	
Lang 2001b	Supplemental Si	No	No	Yes	
Nielsen 2002	Anabolic supplement	No		No	No
Woodward 2005	Omega 3 fatty acids	No		No	
Turner 2005*	Supplemental Si	T	Yes		T
Exercise Study	Parameter altered	OC	DPD	ICTP	Bone Quality
Nielsen 1998a	Onset of training	Yes			Yes
Nielsen 1998b	Onset of training	Yes			Yes
Fenton 1999	Longeing	No			
Hoekstra 1999	Stalling/pastured	Yes	Yes		Yes
Bell 2001	Stalling/pastured	Yes		No	Yes
Nielsen 2002	Weight carrying	Yes		Yes	Yes
Hiney 2004a*	Stalling/forced exercise	Yes	No		Yes
Hiney 2002,2004b	Stalling/forced exercise	T	Yes		Yes

nutritional studies that evaluated DPD concentrations, one showed a treatment difference, one showed a trend for a difference, and one showed no difference. Of four nutritional studies that evaluated ICTP concentrations, only one showed a treatment difference. Only three of the nutritional studies made an evaluation of bone quality (either mineral content or breaking strength). One reported no difference while two showed trends for differences in at least one measured parameter of bone quality.

In contrast, in eight studies examining the impact of exercise on OC, six showed differences, one showed a trend for a difference and one reported no difference. Three studies evaluated DPD in response to alterations in exercise and two studies reported differences while one did not. Two studies used ICTP and one showed a treatment difference while the other did not. Seven of the studies evaluated bone quality and all seven reported a difference in at least one measured parameter.

Discussion

This post-hoc analysis suggest dietary treatments usually failed to result in differences in markers of bone metabolism. In five out of seven nutritional studies, no differences ($P < 0.05$) were seen in any biochemical markers. Additionally, no differences ($P < 0.05$) in measurements of bone quality were seen in the three studies that evaluated such, though modest trends for treatment differences were seen in two of them. In contrast, variations in exercise resulted in differences in bone marker concentrations and in bone quality in seven of eight studies.

A review of papers presented at the 2001 and 2003 Equine Nutrition and Physiology Symposia using markers of bone formation reveals similar findings. Three of five studies failed to find alterations in either bone metabolism markers or bone quality in response to alterations in diet. The studies evaluated increased concentrations of trace minerals (Kavazis et al. 2001), supplemental manganese (Sobota et al. 2001), and inorganic mineral supplementation (Baker et al. 2003). Concentrations of ICTP, but not OC, were altered in response to feeding high Ca, P and Mg (Michael et al. 2001). Peterson et al. (2001) found OC was altered when young horses were fed a diet formulated for rapid growth as compared to slow growth. Unfortunately, no measurements of bone quality were reported in either of the latter two studies.

The two studies that examined the response of horses to alterations in exercise reported that both bone metabolism markers and bone quality were altered. These studies examined forced exercise before the onset of initial training (Williams et al. 2003) and disuse associated with stalling (Henry et al. 2003).

Conclusions

These results suggest exercise plays a much greater role in bone metabolism than do differences in nutrition, particularly if the nutritional differences are relatively minor. This suggests that the horse is capable of altering its absorption of

nutrients to maintain bone health to a much greater degree than it is of maintaining bone strength if not provided adequate exercise.

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