The Role of Vitamin D in Sports Medicine

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Background
• Vitamin D has fundamental effects on numerous tissues and basic physiological processes.
• Vitamin D deficiency has been associated with chronic illnesses such as cancer, infectious diseases, autoimmune diseases, and cardiovascular diseases.

Of relevance to sports medicine are the effects on:
1. Muscle
2. Bone
3. Inflammation/immune function
4. Cartilage/arthritis

Normal Vitamin D levels:
• No consensus on optimal serum levels of 25-hydroxyvitamin D3 (25(OH)D3),

• A level of 32 ng/mL or greater is indicative of sufficient levels.

• Vitamin D deficiency is defined by most experts as a total 25-hydroxyvitamin D level of less than 20 ng/mL.

• Vitamin D insufficiency is defined as a level of 20 to 31 ng/mL

• Vitamin D intoxication is observed when serum levels of 25-hydroxyvitamin D are greater than 150 ng/mL

Prevalence of Vitamin D Insufficiency
• Several recent studies have documented a relatively high prevalence of Vitamin D deficiency or insufficiency:

  - Study of young athletes and dancers: 48% were vitamin D insufficient while another 25% were vitamin D deficient (Constantini, Clin J. Sports Medicine, 2010)
  
  - Retrospective study of preoperative orthopaedic surgery patients: 43% were vitamin D insufficient, and of these 40% had deficient levels. Of note, 52% of the sports service patients, which included patients undergoing
ACL reconstruction and/or meniscus surgery, were vitamin D insufficient, and one-third of these patients had deficient levels (Bogunovic et al, JBJS 2010).

- Vitamin D deficiency also documented in elite athlete population:
  - Study of 89 players on a single National Football League team: 30% of
    the players were deficient while 51% had insufficient levels.
  - Study of 18 elite Australian gymnasts: 15 had insufficient levels, and 6 of
    these athletes had deficient levels (Lovell, Clin. J. Sports Med, 2008)

Vitamin D and Muscle Function
- There has been increasing attention to the role of Vitamin D in muscle function and sports performance.

- Vitamin D has its effect on muscle via several known pathways.

- The active metabolite of vitamin D, 1,25(OH)D3, binds to the muscle nuclear
  hormone receptor, vitamin D receptor (VDR). This pathway promotes gene
  transcription, leading to increased cell protein synthesis and growth

- Vitamin D receptor expression within muscle tissue decreases with age,
  providing a partial explanation as to why athletic performance declines with age

- Studies in vitamin D–deficient rats have shown that supplementation increases
  protein synthesis and muscle mass, with a decrease in the rate of exercise-
  induced muscle cell apoptosis.

- Muscle biopsy specimens from adults with low vitamin D levels show atrophic
  changes predominantly of the type II muscle fibers.

Vitamin D and Athletic Performance
- Seasonal variability of athletic performance within the northern hemisphere was
  reported as early as the mid 1950s, with peak performance occurring during the
  late summer months when sun exposure was maximal and then declining to a
  low point in the winter

- UVB radiation exposure has been thought to improve athletic performance.
  Russian researchers as early as 1938 found improvements in 100-m dash times
  in subjects who had UV radiation as compared with nonirradiated controls

- Ward et al. found a direct relationship between serum 25(OH)D3 levels and
  muscle power, force, velocity, and jump height as determined by jump
  mechanography in girls aged 12 to 14 years (Ward et al, J Clin Endocrinol
  Metab, 2009).
• Foo et al reported an increased hand grip strength in 301 teenage girls with normal vitamin D levels compared with those who were deficient (Foo et al, J. Nutrition 2009)

Vitamin D and Bone
• The role of vitamin D in skeletal bone mineralization and calcium homeostasis is well known
• 1,25(OH)D3 is an important factor in activating intestinal calcium absorption and raising serum calcium concentrations.
• Many studies have identified a direct relationship between serum vitamin D levels and bone mineral density in adults of all races.
• When serum vitamin D levels fall below 30 ng/mL, parathyroid hormone levels are increased, which triggers an increase in osteoclastic activity in bone
• 1,25(OH)D3 directly stimulates osteoblasts to produce receptor activator nuclear factor-kB (RANKL), which in turn enhances osteoclastogenesis and mobilization of calcium from the bone
• This leads to increased risk of stress fractures
• Calcium and vitamin D supplementation significantly decreased the incidence of stress fractures among female military recruits (Lappe et al, J Bone Miner Res. 2008)

Inflammation/immune function
• Vitamin D affects basic immune function
• May have an effect on recovery from illness in athletes – mild immune dysfunction is common in athletes during high levels of stressful training
• Anecdotal reports of improved recovery from upper respiratory infections, etc. in athletes with Vitamin D supplementation

Cartilage/arthritis
• The known pathologic changes in subchondral and periarticular bone in OA provides the possible rationale for a role for Vitamin D in osteoarthritis
• Some epidemiologic studies have shown slower rates of OA progression in individuals with higher Vitamin D levels (Lane et al., Arthritis Rheum 1999; McAlindon et al., Annals Internal Medicine 1996)
• However, other studies show no association
• May need long observation periods to show a difference – small benefits may take years to accrue

References


