Effects of Regional Anesthesia on Experimentally Induced Coffin Joint Synovitis

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Introduction

Currently, there are no specific means for definitively diagnosing navicular disease except in unique or advanced cases. Often this disease is a “catch-all” diagnosis for elusive forelimb lamenesses that respond to a palmar digital nerve block (PDNB).

Recently, the effects of intra-articular and intra-bursal anesthesia on the navicular region has been scrutinized and it has been demonstrated that the navicular area can be desensitized via intra-articular anesthesia of the coffin joint.1–5 This fact has been difficult to explain scientifically. Two separate studies have disputed whether there is communication between the navicular bursa and the coffin joint.6,7 Recent studies suggest, however, that local anesthetic injected into the coffin joint may desensitize important structures related to the navicular apparatus and sole of the foot and that there may be a functional or indirect communication between the coffin joint and navicular bursa.8 This may explain why horses with clinical evidence of navicular disease respond to intra-articular anesthesia of the coffin joint.

These findings confuse the diagnosis of navicular disease further, and complicate the diagnosis of lameness from pain associated with the coffin joint. Intra-bursal anesthesia may be beneficial in distinguishing between the two, but it requires radiographic or fluoroscopic confirmation of needle placement due to the close proximity of the digital flexor sheath and palmar pouch of the coffin joint.1,2,4 Regional anesthesia of the digit has been offered by some clinicians as a means of distinguishing between pain originating from the coffin joint and pain stemming from the navicular area, but this is controversial in the literature. Some references state that the PDNB desensitizes only the palmar/plantar one-third of the coffin joint thereby distinguishing between pure coffin joint disease and navicular disease.9–11 Some clinicians use these criteria to distinguish between coffin joint and navicular pain. Some clinicians believe that if a horse...
responds completely to coffin joint anesthesia and also responds completely to a PDNB, that there is strong evidence that the horse may have navicular disease. However, three recent studies imply that the response to regional anesthesia of the digit is not a reliable method of distinguishing between coffin joint pain and navicular pain.\textsuperscript{1,4,12}

The enervation of the digit of the horse has been studied extensively and consists of two major nerve branches, the medial and lateral palmar digital nerves.\textsuperscript{13} The palmar digital nerves arise from the medial and lateral palmar nerves, adjacent or just proximal to the fetlock joint. These nerves immediately give rise to dorsal branches which are usually referred to as the “dorsal branches of the palmar digital nerves.” The palmar digital nerves, after giving off their dorsal branches, descend abaxial to the deep flexor tendon to the coffin bone where they enter the parietal groove and ramify on the parietal surface of that bone. The palmar digital nerves, distal to the dorsal branches, give off approximately 10 superficial branches between the fetlock joint and the coffin bone. These branches enervate the palmar one-half of the skin of the digit, the digital cushion, corium of the frog, caudal borders of the collateral cartilages, laminar corium of the heels and quarters, and the corium of the sole. The palmar digital nerves also give off 5–10 deep branches. These enervate the palmar pouches of the fetlock joint, digital sheath, distal sesamoidean ligaments, palmar pouch of the pastern joint, part of the coffin joint, and parts of the proximal, middle, and distal phalanges. The dorsal branches of the palmar digital nerves are the area of controversy in the literature. Most sources agree that these nerves enervate the skin on the dorsal half of the digit, the dorsal pouches of the fetlock and pastern joints, extensor branches of the suspensory ligament, common digital extensor tendon, dorsal laminar corium, and the proximal and middle phalanges. Many sources on equine anatomy indicate that the dorsal branches of the palmar digital nerves also enervate the coffin joint and coffin bone. However, one study that worked out the enervation to the digit states that once the dorsal branches enervate the dorsal pastern joint, they remain subcutaneous and superficial to the collateral cartilages descending into the laminar corium of the heels and quarters but more dorsally reaching only the coronary corium.\textsuperscript{13}

Currently, many clinicians believe that horses with uncomplicated synovitis and/or degenerative joint disease (DJD) of the coffin joint may block sound with a PDNB. Others believe that a PDNB only blocks the palmar one-third to one-half of the joint and will not make horses that have coffin joint disease sound. The ability of a PDNB to relieve pain originating in the coffin joint has not been documented in the literature. The objective of this study is to demonstrate the effects of a PDNB on experimentally induced coffin joint synovitis based on a previously proven model for producing lameness from synovitis.

**Materials and Methods:**

**Experimental Animals**

Six adult horses were used in the study. Each horse was videotaped jogging straight away and in a circle going both directions on a hard surface. The tapes were reviewed by a panel of three different lameness diagnosticians and each horse was judged to be clinically sound. Standard radiographs were then made of the forelimb digits of each of these horses and read by a board certified veterinary radiologist. All horses used in the study were judged to be free of radiographic signs of coffin joint and/or navicular disease.

**Experimental Approach**

Each horse was randomly assigned to one of two groups using a random numbers table. One group had lameness induced in the right forelimb and one group in the left forelimb. Lameness was induced in each horse by injecting \textit{E. coli} lipopolysaccharide (LPS) in one of its forelimb coffin joints using a previously proven model for inducing mild to moderate lameness.\textsuperscript{14}

After aseptic preparation, each horse had one of its forelimb coffin joints injected with 2.5 ng of LPS using a standard arthrocentesis site. The horses were stalled for 12 h and then evaluated for lameness by trotting in a straight line and circling in both directions on a hard surface. Each horse was again videotaped. After lameness evaluation, a PDNB was performed on each horse on the lame leg. The PDNB was accomplished by inserting a 25 gauge, five-eighths–inch needle subcutaneously over the palmar digital nerves just proximal to the bulb of the heel. Three milliliters of mepivacaine hydrochloride were deposited over both the medial and lateral nerves. Each block was given 15 min to work and was tested by cutaneous sensation to the bulbs of the heel before re-evaluating lameness. The horses were again videotaped in the same trotting regimen after the block was judged to be in effect.

When the effects of the PDNB were fully evaluated and its effects had worn off, six hours later, a coffin joint block was performed on the same limb. The coffin joint block was accomplished by using a standard arthrocentesis site. Ten milliliters of mepivacaine HCL were injected into the coffin joint. The coffin joint block was given 15 min to work, and again the horses were videotaped at the trot.

The videotaped lameness exams were evaluated by the same panel of three diagnosticians who viewed the horses before lameness induction. After each time period for each block, the horses were graded for the degree of lameness present.
Data Analysis
All videotaped exams were re-recorded onto master tapes in random sequence before they were viewed by the panel. Twenty-five percent of the images were displayed twice so that intra-observer grading consistency could be evaluated. Each clinician worked independently and was unaware of animal identity, limb treated, or time interval.

Changes in lameness scores were evaluated by comparing the medians of the lameness grades assigned to each horse by the three observers for each observation time. The statistical significance of the decrease in lameness scores for each post-anesthetic injection time compared to lameness before anesthetic administration will be tested using the Friedman Test. The cutoff point for individual one-sided hypothesis tests will be calculated using Bonferroni’s inequality. To provide an experiment-level error rate of no more than 0.05, p values < 0.017 will be considered to be statistically significant for the three individual comparisons.

Results
Twelve hours after intra-articular administration of LPS, all horses were lame at the trot (median score = 3). Anesthesia of the palmar digital nerves with mepivacaine hydrochloride as described resulted in complete loss of cutaneous sensation to the bulbs of the heel and a significant reduction in lameness 15 min after injection (median score = 0, p = 0.006). By 6 h, lameness scores were similar to before anesthetic administration (median score = 3). Administration of mepivacaine hydrochloride into the distal interphalangeal joint resulted in significant reduction in lameness 15 min after anesthetic administration (median score = 0, p = 0.006). Intra observer agreement for duplicate recordings was 100%.

Discussion
The results of this study demonstrate that a PDNB performed just above the bulbs of the heel can alleviate pain originating from the coffin joint. These findings validate Sack’s study and other’s suggestions that the dorsal branches of the palmar digital nerves do not reach the coffin joint. The significance of this finding to clinical medicine is that regional anesthesia of the equine digit, as it is currently commonly performed, cannot differentiate coffin joint pain from navicular pain, solar pain, or other causes of palmar heel pain. This fact, combined with studies that have shown that intra-synovial anesthesia of the coffin joint is not specific for coffin joint pain, makes isolation of digital pain in the horse more complicated than we may have previously believed. The volume of mepivacaine (10 mL) that was used to perform intra-synovial anesthesia of the coffin joint was chosen because this is the volume routinely used at our hospitals. We chose to wait 15 minutes to evaluate the horses after each block because we felt that this time exceeded the maximum time that the blocks would take to work but was well under the minimum time a block should last. We felt that it was important that all comparisons be made at a standardized time. Although 15 minutes was an arbitrarily set time to evaluate these blocks and some work has suggested that intra-synovial anesthesia of the coffin joint is complete in 5 minutes, some of these horses were not sound after the coffin joint block until close (10 to 12 minutes) to the 15 minute mark.

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References