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Equine Lameness: an Advanced Review of Classification, Diagnostics Methods Especially with Local Anesthesia, and Management Strategies

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Abstract

Equine lameness, defined by an abnormal gait that impairs movement, is a significant concern in equine health with economic, ethical, and welfare implications. It results in increased veterinary expenses, decreased performance, and reduced horse value, particularly in equine sports, where welfare considerations are paramount. While mild lameness may appear self-limiting, unresolved cases can progress to chronic conditions such as laminitis and musculoskeletal disorders, often causing compensatory strain on the contralateral limb. The pathophysiology of lameness is multifaceted, encompassing biomechanical, orthopedic, and environmental factors, necessitating precise pain assessment for accurate diagnosis and effective treatment. Clinically, lameness is identified through gait abnormalities and localized tenderness, often relying on subjective evaluations; however, advancements in motion analysis technology have improved diagnostic accuracy. Management strategies focus on pain alleviation, disease progression control, and enhancing overall quality of life, particularly in chronic conditions such as osteoarthritis. In severe cases, lameness may lead to euthanasia due to significant functional impairment. Additionally, horses may instinctively mask pain, complicating clinical assessments. A comprehensive literature review was conducted using PubMed, Scopus, and Google Scholar, employing targeted keywords to ensure the inclusion of relevant studies.

Keywords: equine lameness, gait abnormalities, musculoskeletal disorders, pain management, equine welfare, chronic conditions, sports horses.

عرج الخيول: مراجعة متقدمة لتصنيف الحالة، طرق التشخيص، خاصة باستخدام التخدير الموضعي، واستراتيجيات العلاج

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الخلاصة

يُعرَّف العرج في الخيول بأنه اضطراب غير طبيعي في المشي يُعيق الحركة، وهو يُعد مشكلة رئيسية في صحة الخيول، لما له من تأثيرات اقتصادية وأخلاقية ورفاهية. يؤدي العرج إلى زيادة تكاليف الرعاية البيطرية، وانخفاض الأداء، وتراجع قيمة الحصان، لا سيما في رياضات الفروسية، حيث تُعد رفاهية الخيول أولوية أساسية. وعلى الرغم من أن الحالات البسيطة قد تبدو محدودة ذاتيًا، فإن الحالات غير المُعالجة قد تتطور إلى مشكلات مزمنة مثل التهاب الحافر والاضطرابات العضلية الهيكلية، مما قد يؤدي إلى إجهاد تعويضي في الطرف المقابل. يتميز العرج بآلية مرضية معقدة تشمل عوامل ميكانيكية حيوية وعظمية وبيئية، مما يستلزم تقييماً دقيقًا للألم لضمان تشخيص وعلاج فعال. سريريًا، يُشخَّص العرج من خلال ملاحظة اضطرابات المشي والشعور بالألم في المنطقة المصابة، وغالبًا ما يعتمد على التقييمات الذاتية، إلا أن التقنيات الحديثة لتحليل الحركة حسّنت من دقة التشخيص. تركز استراتيجيات العلاج على تخفيف الألم، والحد من تطور المرض، وتحسين جودة الحياة، خاصة في الحالات المزمنة مثل التهاب المفاصل. وفي الحالات الشديدة، قد يؤدي العرج إلى القتل الرحيم بسبب العجز الوظيفي الكبير. كما أن الخيول قد تُخفي الألم غريزيًا، مما يُعقد التقييم السريري. تم إجراء مراجعة شاملة للأدبيات باستخدام قواعد بيانات PubMed وScopus وGoogle Scholar، مع استخدام كلمات مفتاحية محددة لضمان جمع الدراسات ذات الصلة.

1. Introduction

Equine lameness refers to an abnormality in the horse's movement that causes an irregular gait. This issue is of significant concern in equine health, with major implications for both veterinarians and horse owners. Lameness results in substantial economic burdens, including veterinary care costs, treatment, a decrease in performance, and a reduction in the horse's value. It can also compromise rider safety, particularly when it appears suddenly. This problem is especially important in working horses, particularly those engaged in equestrian sports, as it directly affects their well-being [1, 2].

At its onset, lameness may seem like a temporary or minor issue that resolves without intervention. However, without proper treatment, it can lead to long-lasting disabilities, including conditions like laminitis, stress on the opposite limb, or other musculoskeletal problems such as muscle injuries. The causes of equine lameness are multifactorial, involving biomechanical, orthopedic, and environmental factors. Therefore, a thorough evaluation of pain is necessary for a precise diagnosis, particularly in cases where the lameness is not easily visible, as seen in many competitive horses [3-5].

Lameness is typically diagnosed through observing irregularities in movement patterns and detecting tenderness in the affected area. Experienced veterinarians and riders can identify lameness through various movements such as walking or trotting. While subjective methods are commonly used, modern technologies that analyze motion are improving the accuracy and reliability of diagnoses [6].

Accurate identification of lameness is crucial for prompt treatment and preventing complications. Musculoskeletal disorders are prevalent in horses of all ages and breeds, particularly in horses engaged in competitive sports. Horses with chronic musculoskeletal problems may continue participating in events, but their performance often declines once pain becomes evident. Lameness goes beyond just a functional issue; it is also a critical animal welfare concern, especially when it is linked to degenerative conditions like osteoarthritis. Managing lameness is focused on reducing pain, controlling disease progression, and improving the horse's quality of life. It is a leading factor in reduced performance and may sometimes lead to euthanasia if the horse's ability to work is severely impacted. The importance of soundness cannot be overstated, as any unsoundness can severely limit a horse's capabilities, particularly in competitive events such as racing, endurance, or dressage. It is challenging to differentiate between minor unsoundness and normal movement, especially since horses may mask pain due to instinctive survival behavior. This complicates the detection of subtle lameness, creating difficulties for both riders and veterinarians [7].

Chronic unsoundness can lead to persistent pain, which may worsen the horse's overall welfare. Horses suffering from long-term lameness may experience significant discomfort, particularly when their injuries are not properly addressed. In extreme cases, untreated musculoskeletal injuries can cause bone damage or deformities that further hinder mobility and reduce quality of life. Therefore, adopting a holistic approach to pain management, rehabilitation, and welfare is essential to ensure the horse's physical and emotional well-being [8].

2. Classification of Lameness

Lameness is a frequent condition encountered in equine veterinary practice. It is typically classified into two primary categories: anatomical and functional, each serving to enhance the precision of diagnosis and treatment protocols. Anatomical lameness focuses on identifying the specific source of the pathology, which may be further classified into regional categories, such as lameness in the distal limbs, or structural categories, such as injury to ligaments or bones [9]. Functional lameness, however, refers to abnormal movement patterns that result from various underlying issues and is further classified as either absent (clinically sound) or structural in which dysfunction is identified through clinical evaluation and often confirmed using diagnostic techniques such as nerve blocks [10].

In addition to these classifications, lameness can be temporally categorized as either acute or chronic. Acute lameness is often the result of sudden traumatic incidents or environmental factors, while chronic lameness requires a more comprehensive management approach, which includes identifying the root causes and preserving the integrity of the locomotor system. A precise classification system is crucial to facilitate effective diagnostic approaches, individualized treatment strategies, and interprofessional communication among veterinary teams [11].

3. Anatomical vs. Functional Classification

Equine lameness can be categorized into anatomical and functional types. The anatomical classification aims to pinpoint the specific tissue, limb, or structure causing the dysfunction. Examples include musculoskeletal damage, joint issues, or bone abnormalities. This classification assists in localizing the source of pain and addressing conditions that affect the horse's movement and performance [12, 13].

Functional classification, in contrast, is concerned with abnormal movement and performance, without necessarily identifying the specific anatomical problem. For example, it may involve issues such as muscle fatigue or joint instability. These functional problems are often a result of underlying anatomical issues, which manifest as gait abnormalities or reduced performance. As such, a comprehensive diagnostic approach is necessary to consider both anatomical and functional components when treating lameness [14].

Often, lameness results from both structural and functional factors, with anatomical disruptions leading to compensatory functional impairments. Thorough clinical evaluations, including gait assessments and biomechanical analyses, are essential for accurately diagnosing and managing these interrelated factors, thereby improving equine health and performance [15].

4. Acute vs. Chronic Lameness

Acute lameness typically arises from sudden injuries or external factors, causing immediate pain and noticeable gait alterations as the horse compensates for the discomfort. In contrast, chronic lameness develops over time, often resulting from degenerative joint conditions or repetitive stress injuries. Chronic cases may exhibit less intense but persistent discomfort, with recurring inflammation potentially escalating into conditions like arthritis [16].

Early identification of acute lameness allows for prompt treatment, which is essential to prevent complications or progression into chronic conditions. Conversely, chronic lameness often requires long-term management strategies that address both the root cause and secondary complications. Mismanagement of acute injuries can lead to persistent musculoskeletal issues, further underscoring the importance of accurate diagnosis and timely intervention [17, 18].

5. Diagnostic Methods for Equine Lameness

Effective treatment of lameness relies heavily on accurate diagnosis, beginning with a thorough clinical examination. This process involves evaluating the horse's movement, identifying the affected limb, and assessing the nature of the condition-whether it is pain-related or mechanical in origin. Nerve blocks are frequently used to pinpoint the source of discomfort, particularly in complex cases where traditional methods may not yield definitive results.

Advanced diagnostic techniques, such as nerve blocks, are increasingly used to localize the source of lameness during rest and exercise, offering essential insights for accurate prognosis. Radiography is widely utilized for evaluating bone health, while tools like ultrasound, Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and nuclear scintigraphy are most commonly used for bone scans in horses. A radiopharmaceutical is given IV that binds to areas of exposed hydroxyappetite in the bone. This radiopharmaceutical gives off gamma rays that are detected by a gamma camera.

Bone scans are useful for horses with multiple limb lameness, subtle lameness or lameness of the proximal limb, back or pelvis. For example, MRI is particularly effective in diagnosing tendon and ligament injuries, while CT scans are ideal for identifying fractures. Scintigraphy is often used to detect stress-related injuries in areas like the fetlock. Combining these diagnostic tools enables veterinarians to obtain a comprehensive understanding of the horse's condition, particularly in subtle or multifaceted cases [19, 20].

6. Clinical Examination

A clinical examination serves as the foundation for diagnosing equine lameness, combining static and dynamic assessments to identify abnormalities. During static evaluations, veterinarians assess factors such as muscle symmetry, hoof condition, joint alignment, and overall posture. Dynamic assessments, which involve observing the horse's movement at different gaits, provide critical insights into gait irregularities and limb functionality. A methodical approach can identify the source of lameness and other potential pain or functional issues, guiding further diagnostic steps and treatment decisions [21].

Lameness is a clinical sign that requires a combination of art, science, judgment, and experience for accurate interpretation. Often, lameness results from long-term changes and compensatory mechanisms in the body, as the horse adapts to pain. A primary joint issue can lead to widespread effects, including involvement of other joints, soft tissues, and muscles. Chronic or long-term lameness can result in diffuse muscle and tendon stress, regional weakness, compensatory changes in limb length or hoof angle, and altered movement patterns to redistribute stress away from the affected joint.

7. Advanced Imaging Techniques

Advances in imaging technology have significantly improved the diagnosis of lameness in horses, driven by increasing competition in equine sports. Various imaging techniques, such as radiography, ultrasound, endoscopy, thermography, scintigraphy, contrast tenography, and MRI, allow for enhanced visualization of the equine body. Some of these techniques can be performed in the field, while others require specialized clinical settings and equipment, like MRI, CT, digital radiography, and digital ultrasound. Advanced imaging methods, particularly MRI, CT, and scintigraphy, provide more detailed insights into soft tissue diseases and osseous conditions that standard clinical or outpatient imaging cannot reveal [22-24].

These advanced imaging techniques help clinicians confirm or refine clinical findings, sometimes even contradicting initial diagnoses. MRI, as the gold standard for tissue characterization, is particularly valuable in evaluating foot lameness, offering unparalleled visualization of internal anatomy and providing critical information on both soft and hard tissue lesions. Accurate diagnosis is a cornerstone for effectively managing and treating lameness in horses, with imaging technologies playing a pivotal role in this process. The introduction of nuclear imaging methods, such as bone scans or whole-body scans, has further advanced diagnostic capabilities allowing for regional analysis of specific limbs at specialized centers [25, 26].

8. Diagnostic Nerve and Joint Blocks

Evaluation of the horse's history and a systematic diagnostic approach. Local anesthetic techniques, widely used in human medicine for over a century, have become an essential tool in equine diagnostics. These techniques provide temporary sensory blockage, enabling veterinarians to pinpoint sources of pain that might not be evident through physical examination or imaging alone. This method is instrumental in developing an accurate diagnosis and formulating an effective treatment plan [27].

Techniques such as nerve and joint blocks are commonly utilized to desensitize specific nerves and their associated anatomical regions, including skin, muscle, fascia, and bone. The precise administration of these blocks is critical, as overlapping sensory regions can complicate interpretations. Methods like perineural injections, remote infiltration, and intra-articular analgesia require a strong understanding of equine anatomy and refined technical skills to minimize risks. Although these procedures are highly effective, they carry potential side effects and the risk of misinterpreting results. Nonetheless, these techniques remain indispensable in accurately identifying the primary source of lameness, significantly enhancing diagnostic accuracy and informing tailored treatment strategies [28].

9. Local Anesthesia in Equine Lameness Diagnosis

The primary objective of an equine lameness evaluation is to diagnose musculoskeletal conditions by accurately identifying the source of discomfort. This process often involves the use of local anesthetics to temporarily block sensory and motor nerve functions within the affected

region. Selecting the appropriate injection site, anesthetic type, and duration of effect, while accounting for potential confounding factors, is crucial to achieving reliable results. Local anesthesia promotes vasodilation, enhancing blood circulation in the targeted area and limiting systemic absorption. However, when administered intravenously, elevated plasma levels can occasionally lead to systemic toxicity or adverse side effects [29].

Local anesthesia is vital for further diagnostic procedures such as imaging or evaluating therapeutic interventions like intra-articular treatments. Fast-acting anesthetics, including lidocaine, bupivacaine, and mepivacaine, are commonly used. Techniques to produce nerve plexus anesthesia with a single injection are widely practiced, although the procedure may cause discomfort. Sedatives or opioid analgesics such as detomidine, xylazine, butorphanol, or morphine are often co-administered to improve patient comfort. Local anesthesia is particularly advantageous during diagnostic imaging, like MRI, for marking sites of interest.

The ethical and legal implications of local anesthetic use in equine sports and practice must be considered. Only a few substances are legally approved for use under specific conditions in equestrian sports. Ethically, local anesthetics should be applied judiciously, avoiding unnecessary use. If no clear indication exists, alternatives such as placebos may be used, particularly in diagnostic imaging contexts.

10. Principles and Techniques

The principles of anesthetic techniques remain stable, though the agents used may vary. Local anesthetics function by blocking nerve conduction, reversing the axon's charge to prevent action potentials and numbing pain. The effect dissipates as the drug diffuses away from the nerve. Proper administration requires precise targeting, with attention to anatomical landmarks to avoid vascular or neurological structures. Superficial local anesthetics are frequently used for distal analgesia in equine lameness evaluations.

Diagnostic blocks should last about 30 minutes and must precede any lameness diagnosis. Selection of the anesthetic solution depends on patient biosecurity, potential side effects, and the required duration of action. Accurate disinfection, sedation, and guidance during needle insertion are essential to prevent complications. Techniques such as umbilical gauze can help ensure correct injection, but care must be taken to avoid injuries due to improper needle handling. Evidence-based methods and proper preparation are crucial for safe and effective outcomes [30].

11. Commonly Used Local Anesthetic Agents

Local anesthetic agents used in equine veterinary practice possess distinct properties, with their effectiveness influenced by pharmacokinetic and pharmacodynamic factors. Typically, nerve blocks require 30 minutes to take full effect, although certain blocks, such as digital or heel blocks, may take 30 to 45 minutes to be fully effective. This delay should be considered when planning diagnostic or anesthetic procedures. The risk of harm when using local anesthetics in synovial, intra-joint, or perineural injections is low when performed under proper field conditions [31].

Pharmacokinetic differences between local anesthetics, such as bupivacaine, mepivacaine, and trimecaine (lipophilic agents), and lidocaine (a water-soluble agent), influence their onset of action.

Lipophilic agents have a slower onset due to the hydrophobic nature of most membranes, while hydrophilic agents tend to cross membranes more quickly, contributing to faster effects. Further comparative studies are required to determine the optimal use of these agents in equine medicine. Local anesthetics work by inhibiting voltage-gated sodium channels, thereby disrupting the processes of depolarization and repolarization. At appropriate doses, these agents keep the sodium channels closed, reducing neuronal excitability and signal conduction. When administered in sufficient amounts, they induce conduction failure, preventing the reactivation of neural signals during the critical refractory period, which underlies their anesthetic effect [32, 33].

12. Management Strategies for Equine Lameness

Managing equine lameness requires a multifaceted approach, incorporating both conservative and surgical interventions. Treatment selection is based on an initial evaluation of the injury, considering factors such as severity, duration, and the horse's specific needs. The primary objective is to restore soundness, with rehabilitation strategies tailored to the condition's complexity and the trainer's preferences. Conservative treatments typically involve rest, cryotherapy, and structured exercise regimens, while more severe cases may necessitate surgical procedures. Veterinary interventions, including pharmaceutical treatments, sedatives, intra-articular injections, and dietary supplements, also play a crucial role in lameness management [1].

The approach to treatment varies depending on the nature and location of the injury. Mild cases often respond well to non-invasive methods, whereas moderate lameness may require prolonged conservative care to prevent further complications. Rehabilitation is a key aspect of recovery, preventing muscle stiffness and overall deconditioning. Controlled physical activity, particularly in tendon injuries, promotes tissue regeneration. An essential part of treatment is gradually reintroducing the horse to work while adapting the management strategy to align with the trainer's requirements. This involves periodic reassessment of the injury, modification of exercise regimens, and collaboration with trainers, riders, and stable managers to ensure a safe recovery process [3].

A structured rehabilitation program should emphasize gradual increases in movement, incorporating activities such as extended pasture turnout and supervised hand-walking. Returning to work too soon, even at a reduced intensity, may hinder the healing process, particularly in performance horses. Therefore, post-injury management must be carefully structured to prevent recurrence and minimize excessive strain on the recovering limb Proper therapy and careful assessment before and after rehabilitation are vital to ensure success and minimize setbacks [34].

13. Conservative vs. Surgical Management

Conservative management of equine lameness focuses on promoting tissue healing and restoring function without the need for surgery. Common conservative approaches include rest (stall or pasture), analgesic medications (NSAIDs or opioids) to manage pain, and alternative therapies like

acupuncture, chiropractic care, shockwave therapy, and regenerative medicine. Rehabilitation protocols are individualized and may involve non-riding activities such as physical therapy, controlled exercise, and hand walking or jogging [35, 36].

Surgical interventions, on the other hand, may facilitate tissue healing, improve joint function, or provide diagnostic evaluation. Surgical decisions depend on the severity of the condition, the response to initial treatment, and the risks associated with the procedure. Surgical risks, such as potential damage to surrounding tissues, can impede recovery. Therefore, the decision to proceed with surgery should involve a careful assessment of the benefits and risks, taking into account the nature of the injury, the veterinarian's expertise, and the resources available to the client. In some situations, a combination of conservative and surgical treatments may be required to achieve optimal outcomes. Ultimately, the veterinarian's professional judgment plays a crucial role in determining the best course of action based on the individual case.

14. Rehabilitation and Physical Therapy

Rehabilitation for equine lameness focuses on restoring the horse's normal musculoskeletal function, biomechanics, and structure, aiming to bring the animal back to its full athletic capability or, at the very least, its maximum pain-free performance. The rehabilitation strategy must be customized for the individual injury, involving cooperation between the veterinarian and a certified physiotherapist. Various therapeutic techniques are employed, such as controlled exercise, hydrotherapy, massage, acupuncture, kinesiology taping, blood flow restriction, PEMF therapy, and multiwave therapy. The success of the rehabilitation program should be regularly assessed, with modifications made based on progress. Rehabilitation is especially important after long periods of rest or confinement, as it helps prevent re-injury by strengthening critical muscles and enhancing long-term soundness. Having a skilled rehabilitation team is vital for maintaining the horse's overall health and managing the recovery process [37, 38].

15. Conclusion

Equine lameness continues to be a challenging issue that requires a comprehensive approach. Advancements in diagnostic imaging, biomechanical evaluation, and regenerative treatments provide new avenues for improving outcomes. Ongoing research will help refine these techniques, followed by appropriate management strategies to ensure the horse's well-being and performance.

References

[1] J. Müller-Quirin, M. T. Dittmann, C. Roepstorff, S. Arpagaus, S. N. Latif, and M. A. Weishaupt, "Riding soundness—comparison of subjective with objective lameness assessments of owner-sound horses at trot on a treadmill," *Journal of equine veterinary science,* vol. 95, p. 103314, 2020.

[2] A. Radtke, L. Fortier, S. Regan, S. Kraus, and M. Delco, "Intra-articular anaesthesia of the equine stifle improves foot lameness," *Equine veterinary journal,* vol. 52, pp. 314-319, 2020.

[3] F. Mata, I. Franca, J. Araújo, G. Paixão, K. Lesniak, and J. L. Cerqueira, "Investigating Associations between Horse Hoof Conformation and Presence of Lameness," *Animals,* vol. 14, p. 2697, 2024.

[4] S. D. Starke and S. A. May, "Expert visual assessment strategies for equine lameness examinations in a straight line and circle: A mixed methods study using eye tracking," *Veterinary Record,* vol. 191, pp. no-no, 2022.

[5] A. M. Hardeman, A. Egenvall, F. M. Serra Bragança, M. H. Koene, J. H. Swagemakers, L. Roepstorff, *et al.*, "Movement asymmetries in horses presented for prepurchase or lameness examination," *Equine Veterinary Journal,* vol. 54, pp. 334-346, 2022.

[6] A. S. Wong, A. V. Morrice-West, P. L. Hitchens, and R. C. Whitton, "The association between Thoroughbred racehorse training practices and musculoskeletal injuries in Victoria, Australia," *Frontiers in Veterinary Science,* vol. 10, p. 1260554, 2023.

[7] A. Paris, F. Beccati, and M. Pepe, "Type, prevalence, and risk factors for the development of orthopedic injuries in endurance horses during training and competition," *Journal of the American Veterinary Medical Association,* vol. 258, pp. 1109-1118, 2021.

[8] J. Ladewig, A. N. McLean, C. L. Wilkins, K. Fenner, J. W. Christensen, and P. D. McGreevy, "A review of The Ridden Horse pain Ethogram and its potential to improve ridden horse welfare," *Journal of Veterinary Behavior,* vol. 54, pp. 54-61, 2022.

[9] R. Bras and S. Morrison, "Mechanical Principles of the Equine Foot," *The Veterinary Clinics of North America. Equine Practice,* vol. 37, pp. 581-618, 2021.

[10] I. L. Reis, B. Lopes, P. Sousa, A. C. Sousa, A. R. Caseiro, C. M. Mendonça, *et al.*, "Equine musculoskeletal pathologies: clinical approaches and therapeutical perspectives—a review," *Veterinary Sciences,* vol. 11, p. 190, 2024.

[11] D. Koch, M. Barrett, B. Jackman, D. MacDonald, and L. Goodrich, "Comparison of lameness outcomes in horses with acute or chronic digital lameness that underwent magnetic resonance imaging," *New Zealand Veterinary Journal,* vol. 68, pp. 283-288, 2020.

[12] A. Moore, E. Fisher, and C. Eccleston, "Reply to Beaulieu," *Pain,* vol. 162, p. 2310, 2021.

[13] A. L. Jenkins III, J. O'Donnell, R. J. Chung, S. Jenkins, C. Hawks, D. Lazarus, *et al.*, "Redefining the classification for Bertolotti syndrome: anatomical findings in lumbosacral transitional vertebrae guide treatment selection," *World Neurosurgery,* vol. 175, pp. e303-e313, 2023.

[14] R. Rupp, F. Biering-Sørensen, S. P. Burns, D. E. Graves, J. Guest, L. Jones, *et al.*, "International standards for neurological classification of spinal cord injury: revised 2019," *Topics in spinal cord injury rehabilitation,* vol. 27, p. 1, 2021.

[15] M. Ripollés-Lobo, D. I. Perdomo-González, M. Valera, and M. D. Gómez, "Conformational Defects in the Limbs of Menorca Purebred Horses and Their Relationship to Functionality," *Animals,* vol. 14, p. 1071, 2024.

[16] F. M. S. Barbosa, I. R. Dos Santos, G. G. Costa, C. E. Lopes, S. P. Pavarini, and D. Driemeier, "Lameness and fever in a 3-year-old female English Thoroughbred horse," *Journal of the American Veterinary Medical Association,* vol. 1, pp. 1-4, 2024.

[17] G. Pearson, N. Waran, R. J. Reardon, J. Keen, and C. Dwyer, "A Delphi study to determine expert consensus on the behavioural indicators of stress in horses undergoing veterinary care," *Applied Animal Behaviour Science,* vol. 237, p. 105291, 2021.

[18] M. Hausberger, N. Lerch, E. Guilbaud, M. Stomp, M. Grandgeorge, S. Henry, *et al.*, "On-farm welfare assessment of horses: The risks of putting the cart before the horse," *Animals,* vol. 10, p. 371, 2020.

[19] L. Pezzanite, E. Contino, and C. Kawcak, "Lameness originating from the proximal metacarpus/tarsus: a review of local analgesic techniques and clinical diagnostic findings," *Equine Veterinary Education,* vol. 32, pp. 204-217, 2020.

[20] P. Tually, G. Currie, D. Blache, J. Meadows, C. Gray, L. Hemmings, *et al.*, "Concurrent measurement of serum and radiomic biomarkers in the clinical investigation of equine musculoskeletal injuries: A prospective pilot study," *Veterinary radiology & ultrasound,* vol. 64, pp. 484-491, 2023.

[21] Y. Qiao, H. Kong, C. Clark, S. Lomax, D. Su, S. Eiffert, *et al.*, "Intelligent perception-based cattle lameness detection and behaviour recognition: A review," *Animals,* vol. 11, p. 3033, 2021.

[22] A. Janevski, B. Dimitrievski, E. Murdzeva, D. Bozhinovski, B. Nikolova, and D. Mitrov, "Hypertrophic osteopathy associated with lung adenocarcinoma in a cat: An overview," *Acta Veterinaria-Beograd,* vol. 73, pp. 279-288, 2023.

[23] M. Vandersmissen, L. Evrard, A. Charles, F. Audigié, and V. Busoni, "Diagnostic imaging findings in lame Warmblood horses with bone injuries of the medial proximal phalanx glenoid cavity," *Veterinary Radiology & Ultrasound,* vol. 66, p. e13449, 2025.

[24] C. Riley, "Systematic equine lameness localisation and the place of new technologies," 2021.

[25] C. A. Byrne, J. F. Marshall, and L. C. Voute, "Clinical magnetic resonance image quality of the equine foot is significantly influenced by acquisition system," *Equine Veterinary Journal,* vol. 53, pp. 469-480, 2021.

[26] L. Evrard, Z. Joostens, M. Vandersmissen, F. Audigié, and V. Busoni, "Comparison between ultrasonographic and standing magnetic resonance imaging findings in the podotrochlear apparatus of horses with foot pain," *Frontiers in Veterinary Science,* vol. 8, p. 675180, 2021.

[27] U. Chavkin, J. Pitaro, H. Gavriel, A. Taha, L. Muallem Kalmovich, S. Shilo, *et al.*, "The impact of eustachian tube function on intra-tympanic steroid administration," *European Archives of Oto-Rhino-Laryngology,* vol. 280, pp. 143-149, 2023.

[28] R. C. Cole, F. J. DeGraves, J. Schumacher, and J. Brown, "Lameness of horses is effectively ameliorated with a low volume of mepivacaine administered as a palmar digital nerve block," *American Journal of Veterinary Research,* vol. 1, pp. 1-6, 2024.

[29] M. Khadavi, D. Rehor, A. Roney, L. Podesta, and D. R. Smith, "Regional anesthesia for orthobiologic procedures," *Physical Medicine and Rehabilitation Clinics,* vol. 34, pp. 291-309, 2023.

[30] M. Misal, M. Girardo, and M. N. Wasson, "Surgical decision regret in women pursuing surgery for endometriosis or chronic pelvic pain," *Journal of Minimally Invasive Gynecology,* vol. 28, pp. 1343-1350, 2021.

[31] V. Uppal, R. Sondekoppam, R. Landau, K. El-Boghdadly, S. Narouze, and H. Kalagara, "Neuraxial anaesthesia and peripheral nerve blocks during the COVID-19 pandemic: a literature review and practice recommendations," *Anaesthesia,* vol. 75, pp. 1350-1363, 2020.

[32] J. Körner, S. Albani, V. Sudha Bhagavath Eswaran, A. B. Roehl, G. Rossetti, and A. Lampert, "Sodium channels and local anesthetics—old friends with new perspectives," *Frontiers in pharmacology,* vol. 13, p. 837088, 2022.

[33] X. Hao, M. Ou, D. Zhang, W. Zhao, Y. Yang, J. Liu, *et al.*, "The effects of general anesthetics on synaptic transmission," *Current neuropharmacology,* vol. 18, pp. 936-965, 2020.

[34] T. O. Ratcliffe, P. Robinson, and S. M. Rosanowski, "The prognosis for return to athletic function for Thoroughbred racehorses in Hong Kong with injuries to the palmaroproximal aspect of the metacarpus diagnosed using low-field magnetic resonance imaging," *Journal of the American Veterinary Medical Association,* vol. 262, pp. 383-390, 2024.

[35] K. Kirkby Shaw, L. Alvarez, S. A. Foster, J. E. Tomlinson, A. J. Shaw, and A. Pozzi, "Fundamental principles of rehabilitation and musculoskeletal tissue healing," *Veterinary Surgery,* vol. 49, pp. 22-32, 2020.

[36] W. Hao, L. Fang, S. Yin, Y. Lin, and B. Wang, "Reverse wedge effect following intramedullary nail fixation of trochanteric fracture, what does it imply?," *BMC Musculoskeletal Disorders,* vol. 22, p. 497, 2021.

[37] T. Atalaia, J. Prazeres, J. Abrantes, and H. M. Clayton, "Equine rehabilitation: a scoping review of the literature," *Animals,* vol. 11, p. 1508, 2021.

[38] P. Lightsey, Y. Lee, N. Krenek, and P. Hur, "Physical therapy treatments incorporating equine movement: a pilot study exploring interactions between children with cerebral palsy and the horse," *Journal of neuroengineering and rehabilitation,* vol. 18, pp. 1-11, 2021.