Check for updates

Received: 16 January 2026 | Accepted: 20 May 2026

DOI: 10.1111/eve.70132

Equine Veterinary Education BEVA

REVIEW ARTICLE

Updates on intra-articular corticosteroid administration in horses

K. Tanner[1] | L. Bass[2] | C. Kawcak[2] | L. V. Schnabel[3,4] | K. L. Hallowell[3] | L. M. Pezzanite[2]

[1]Texas Tech School of Veterinary Medicine, Amarillo, Texas, USA

[2]Orthopaedic Research Center, Department of Clinical Sciences, Translational Medicine Institute, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, Colorado, USA

[3]Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina, USA

[4]Comparative Medicine Institute, North Carolina State University, Raleigh, North Carolina, USA

Correspondence: L. M. Pezzanite
Email: lynn.pezzanite@evj.co.uk

Summary

Intra-articular (IA) corticosteroid administration in equine athletes has gained increased attention recently, particularly in racing. Despite widespread corticosteroid use in equine practice for decades, there are still a lack of equine-specific studies to address key questions related to their use. Extrapolation of best practices from human literature supports that while IA corticosteroids elicit transient symptom-modification of osteoarthritis (OA), they can have deleterious effects on articular cartilage depending on drug selection, dose and time- indicating the lowest efficacious dose should be used to achieve clinical benefit. While there are limited data supporting current clinical protocols related to dose or injection frequency diminishing returns have been noted with multiple-injection protocols. Recent studies have led to heightened awareness of equine endocrinopathies and the sensitivity of equine patients with those disorders to the effects of steroids, putting them at increased risk for complications such as laminitis and secondary infection. These findings prompt reconsideration of long-term or high-dose corticosteroid administration, particularly given the evolution of alternative IA orthobiologic and immunomodulatory therapies for OA, which require further investigation and comparison for relative modification of clinical signs and disease progression. As much of the referenced literature does not permit direct comparisons across studies, further research is needed to compare corticosteroids at equivalent body doses and dosing intervals in horses with and without endocrinopathies. Without such studies, definitive evidence linking IA corticosteroid use to laminitis risk, subchondral bone injury or catastrophic injury is lacking at this time. This narrative review seeks to summarise the current literature available as well as gaps in knowledge on equine IA corticosteroid use for the practising clinician.

KEYWORDS
horse, corticosteroid, intra-articular

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2026 The Author(s). *Equine Veterinary Education* published by John Wiley & Sons Ltd on behalf of EVJ Ltd.

INTRODUCTION

Corticosteroids have been widely used in both human and veterinary medicine for decades as potent anti-inflammatory agents to manage osteoarthritis (OA). The intra-articular (IA) route of administration is favoured to deliver high drug concentrations directly to the affected joint, producing rapid and effective pain relief while minimising systemic exposure and potential side effects. In equine practice, IA corticosteroid injections have remained a cornerstone of lameness management, providing improvement in signs of mobility and pain, and in doing so prolonging athletic careers (Zanotto & Frisbie, 2021). In humans, IA corticosteroid injections are also frequently implemented to treat joint disease due to their accessibility, relatively low cost and demonstrated symptomatic relief, albeit generally short-term (Guermazi et al., 2020). These advantages have made corticosteroids an attractive and widely utilised therapeutic option across species.

Despite these benefits, concerns have been raised over the long-term safety and potential consequences of IA corticosteroid use. Experimental and clinical studies in horses and other species suggest potential deleterious effects on articular cartilage depending on the drug selected and particularly with repeated or high-dose administration (Goodrich & Nixon, 2006; Kawcak et al., 1998; Sherman et al., 2015; Trotter et al., 1991). Similar concerns about repeated intra-articular corticosteroid administration have been raised in human medicine, with current guidelines recommending cautious use due to potential progression of structural damage within the joint after frequent injections (AAOS, 2021; Benzon et al., 2025; Kolasinski et al., 2019). Reported risks include chondrotoxicity, acceleration of OA progression and potential contribution to musculoskeletal injury through masking of pain or altered biomechanics, although a direct causal link remains debated (McIlwraith & Lattermann, 2019; Whitton et al., 2014). Additionally, practitioners are becoming more aware of the systemic metabolic risks of corticosteroid use, and particularly the risk of corticosteroid-associated laminitis (Manfredi et al., 2023). These findings have led to increasing caution in routine use, especially given the emergence of alternative therapies such as orthobiologics or viscosupplements, which aim to provide longer-term disease modification (McIlwraith, 2010; Wernecke et al., 2015). Such lack of clarity underscores the importance of critically re-examining corticosteroid use within the context of current scientific evidence.

This review aims to summarise the scientific rationale and current clinical evidence for IA corticosteroid use in horses, providing the most recent information available related to use with concurrent endocrinopathothies while utilising comparative human literature to provide a broader translational perspective. While corticosteroids remain a mainstay of equine joint therapy, the growing body of literature on potential risks has prompted a reconsideration of best practices, including drug selection, timing of injection, rest period prior to exercise and combination with other therapies. This review therefore seeks to provide an updated, clinically relevant summary of the available literature for equine practitioners, integrating insights from both human and equine studies and offering practical considerations in response to frequently asked questions surrounding corticosteroids (summarised in Table 1).

HISTORICAL PERSPECTIVE ON INTRA-ARTICULAR CORTICOSTEROID ADMINISTRATION IN HUMANS AND HORSES

History and summary of available corticosteroid options to practitioners

The use of intra-articular corticosteroids (IACs) in people dates back to the early 1950s, when Hollander et al. first described corticosteroid injections for human rheumatoid arthritis, offering rapid symptom relief and functional improvement (Hollander et al., 1951). In human sports medicine today, corticosteroid injections are still widely used to treat OA of the knee, hip, and shoulder joints, selected for their relatively rapid onset and short-term analgesic benefits (Guermazi et al., 2020). Systematic reviews report that triamcinolone acetonide (TA) and methylprednisolone acetate (MPA) remain the most studied formulations. TA is often favoured for a comparatively higher cartilage safety profile in experimental models, resulting in less suppression of proteoglycan synthesis and more consistent preservation of cartilage endpoints at clinically relevant doses (Dechant et al., 2003; Frisbie et al., 1997; Guermazi et al., 2020; Wernecke et al., 2015). The parallel evolution of IACs across species reflects the shared challenges of balancing short-term symptom relief with long-term joint health.

In equine practice, corticosteroid use was adopted in the 1970s and 1980s, driven by the need to manage lameness associated with OA in performance horses (McIlwraith, 2010). Since then, multiple corticosteroid preparations have been employed in equine practice, including TA, MPA, betamethasone esters (BM), isoflupredone acetate (IPA) and dexamethasone sodium phosphate (DEX) (Zanotto & Frisbie, 2021). Each corticosteroid option varies in solubility, duration of action and chondrotoxic potential, influencing practitioner choice depending on the joint and clinical goals (McIlwraith & Lattermann, 2019; Tokawa et al., 2025). Among these, the use of dexamethasone as an intra-articular therapy is relatively uncommon in equine practice. This likely reflects its shorter duration of action and limited evidence of prolonged clinical benefit compared with TA, betamethasone esters or MPA, which remain the primary corticosteroids selected for intra-articular administration in performance horses (McIlwraith & Lattermann, 2019; Zanotto & Frisbie, 2021).

Mechanism of action of corticosteroids

Corticosteroids exert their therapeutic effects primarily through modulation of the inflammatory and immune cascades within the

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 Frequently asked questions (FAQ) on intra-articular corticosteroid use.

Question	Evidence-based answer (with citations)
If 1–2 weeks of rest is not feasible, what is the minimum time needed for efficacy after injection?	Most corticosteroids exert measurable intra-articular effect within 48–72 h, with maximal benefit by 7–14 days. With short rest (e.g., 2–3 days) early anti-inflammatory effects may still be seen although duration of benefit may be reduced (McIlwraith, 2010; Tokawa et al., 2025)
What is the maximum amount of steroid safe per horse and more specifically how much total is safe in one visit if injecting multiple joints	Common clinical dosing of TA is 6–12 mg for large joints and 2–4 mg for small joints, 20–40 mg of MPA for a single joint or 4–6 mg of Betamethasone for a single joint. There is no known intra-articular maximum dosage for a single visit. It is advised, if possible, to stage injections of multiple joints over 1 to 2 weeks due to evidence suggesting systemic effects increase with higher cumulative doses; however, in instances where horses may travel long distances for injections, it is acknowledged that this may not be feasible. To minimise systemic risk, many clinicians based on commonly cited clinical practice try to stay under 16–20 mg/visit of TA, 300 mg/visit of MPA and 18–20 mg/visit of BM total per visit, particularly in horses travelling long distances where staging injections is not feasible (Tokawa et al., 2024; Zanotto & Frisbie, 2021)
How often can joint injections be repeated (3–4 months vs. 6 months)?	There is not a universal interval that exists in the literature. Most guidelines recommend no more frequently than every 3 months, with maintenance of improvement for 4–6 months post injection depending on severity, type of steroid and workload (Kawcak et al., 1998; McIlwraith, 2010; Tokawa et al., 2024)
What frequency is considered safe when injecting an arthritic joint?	Repeated IAC injections administered at short intervals may increase the risk of cartilage damage. The best supported guideline is less than 4 injections per year per joint, staging by more than 3 months between injections whenever possible (Trotter et al., 1991; Whitton et al., 2014; Zanotto & Frisbie, 2021). However, 'the lowest dose at the lowest frequency' to achieve desired affects is suggested.
Can IA steroids be used in horses with EMS?	If possible, corticosteroids should be avoided in patients with EMS, even if the patient is currently well-controlled. If based on a cost–benefit analysis for the individual case corticosteroids are deemed necessary, the minimum effective dose should be selected. Additionally, restricting or eliminating grain meals for 1 to 2 weeks following injection may be beneficial to reduce the risk of severe post-prandial hyperinsulinaemia (Palmer et al., 2025)
Can MPA and TA be maximised at the same time in one horse? (e.g., MPA in tarsal joints, TA in stifles/ distal interphalangeal joints)	Yes, MPA and TA can be used in different joints of the same horse if each drug is used within its indications (Kawcak et al., 1998; McIlwraith, 2010; Trotter et al., 1991). There is no evidence that using both in separate joints creates added risk, but total corticosteroid load and injection frequency should still be considered, as repeated IA corticosteroid exposure may increase cartilage injury risk (Whitton et al., 2014; Tokawa et al., 2025)
Can I measure insulin concentration pre-injection to predict laminitis risk?	Single time-point insulin concentrations, particularly on fasted patients, are poorly sensitive for EMS diagnosis (Hallowell et al., 2026; Olley et al., 2019). Practitioners should use caution when evaluating insulin concentrations prior to injection as normal values may result in a false sense of security. Where possible, dynamic insulin testing with an oral sugar test/oral glucose test should be performed in patients suspected of having EMS prior to pursuing corticosteroid treatment. Alternatively, measurement of insulin 1 to 2 h post-grain meal or while on pasture may provide useful information on the patient's insulin response to current management and is likely a better screening tool than fasted samples As stated above, corticosteroids should be avoided in patients previously diagnosed with EMS, regardless of insulin concentration at time of injection
Can IA steroids be used in horses with PPID?	In patients with well-controlled PPID, the risk of using corticosteroids is likely not substantially greater than that of a horse without PPID, although studies examining the impact of IA corticosteroids on patients with PPID are lacking. Corticosteroids should be avoided in patients with poorly controlled PPID, and if necessary, should be used at the minimum effective dose with close monitoring following injection for signs of laminitis or septic arthritis

joint. Once administered intra-articularly, corticosteroids diffuse across cell membranes and bind to cytoplasmic glucocorticoid receptors. This complex translocates to the nucleus, where it alters gene transcription by downregulating the expression of pro-inflammatory cytokines such as interleukin-1β (IL-1β), tumour necrosis factor-α (TNF-α) and cyclooxygenase-2 (COX-2). Concurrently, corticosteroids upregulate anti-inflammatory mediators, including lipocortin-1, which inhibits phospholipase A2 and reduces arachidonic acid metabolism. These genomic effects suppress the synthesis of prostaglandins and leukotrienes, dampening synovial inflammation and immune activation (Guermazi et al., 2020; McIlwraith, 2010; Wernecke et al., 2015).

In addition to their impact on gene expression, corticosteroids exhibit rapid non-genomic effects that contribute to early pain relief. These include modulation of cell membrane receptors, ion transport mechanisms and secondary messenger pathways within synoviocytes and chondrocytes. Collectively, these local and cellular effects result in reduced synovial effusion, diminished inflammatory cell infiltration and improved joint comfort. However, experimental studies suggest that excessive or repeated corticosteroid exposure

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

can suppress chondrocyte metabolism, impair extracellular matrix synthesis and alter cartilage structure. These findings are primarily reported in experimental models involving repeated administration or high doses and may not directly reflect the effect of a single clinically relevant injection (Bolt et al., 2008; Dechant et al., 2003; Trotter et al., 1991).

Evidence for symptom/sign and disease modification

Corticosteroid injections remain one of the most effective interventions to rapidly improve joint comfort in horses with OA. Corticosteroids are not currently considered disease-modifying due to a lack of documented ability to mitigate or prevent OA progression, although they may reduce clinical signs, complementing other management strategies to allow horses to remain in training or competition (Tokawa et al., 2025). TA has shown consistent efficacy in both experimental models and clinical cases, improving lameness scores, reducing synovial inflammation and restoring short-term performance (Frisbie et al., 1997; McIlwraith, 2010). Historically, MPA was used in low-motion joints such as the proximal interphalangeal, distal intertarsal and tarsometatarsal joints (Zanotto & Frisbie, 2021). Literature on the relative chondrotoxicity of available corticosteroids at equivalent doses and dosing intervals across the range of doses potentially used clinically is lacking. Trotter et al. (1991) is frequently referenced with respect to reporting adverse effects of MPA on cartilage; however, it is important to acknowledge that a moderately high (100 mg) dose was used at a frequent dosing interval (every 2 weeks for three doses) in only four healthy young horses, which is neither advised nor common in clinical practice (Trotter et al., 1991). More recently, Beggan et al. (2025) have reported chondral delamination with co-administration of TA and gentamicin in stifle joints (Beggan et al., 2025). These findings highlight that chondrotoxicity may be possible across steroid classes, depending on dose, frequency and concurrent administration of antimicrobials such as aminoglycosides which also have reported toxicity to equine joint cells (Pezzanite et al., 2021). Current clinical guidelines at the authors' practice preferentially integrate the use of TA in both high and low motion joints due to its potentially favourable chondroprotective profile when not used with aminoglycoside antibiotics and reliable analgesic effects (McIlwraith & Lattermann, 2019).

Human literature parallels these findings, with multiple randomised controlled trials and meta-analyses describing significant short-term symptom relief with IACs. Onset of alleviation of discomfort is often within days of injection, with reported effects waning within 4–12 weeks (Guermazi et al., 2020; Wernecke et al., 2015). In both horses and humans, IACs do not appear to halt disease progression; rather, their value lies in dampening inflammation and mitigating clinical signs long enough to enable rehabilitation or prolong athletic careers (Tokawa et al., 2025).

Evidence for deleterious effects on cartilage

A central concern with IAC use is potential chondrotoxicity. In commonly cited equine studies, repeated moderately high-dose (100 mg) injections of MPA into normal middle carpal joints at a dosing interval not recommended or commonly used in practice (three doses at 2-week intervals) resulted in decreased proteoglycan synthesis and structural integrity of the articular cartilage (Murray et al., 1998; Trotter et al., 1991). Subsequent experimental and in vitro investigations have similarly demonstrated that IAC exposure as a whole can alter chondrocyte metabolism and extracellular matrix turnover, particularly with repeated dosing or high concentrations (Bolt et al., 2008; Dechant et al., 2003; Wernecke et al., 2015). In contrast, studies working with TA suggest model and dose-dependent effects rather than being uniformly chondroprotective, with evidence for preservation of chondrocyte viability and cartilage endpoints in some models (Bolt et al., 2008; Dechant et al., 2003; Frisbie et al., 1997). These findings may support preferential use of TA, especially in high-motion joints where preserving cartilage integrity is critical to long-term joint health, although further studies are needed to systematically compare equivalent doses and total body doses in systemically healthy versus endocrinopathic horses. Equine-specific review articles have emphasised an increased risk with repeated IAC exposure previously, with evidence suggesting that repetitive or short-interval injections may contribute to cumulative cartilage stress and worse long-term outcomes (Tokawa et al., 2024; Wernecke et al., 2015). Additionally, Beggan et al. (2025) described chondral delaminations in equine stifle joints, particularly in younger horses, highlighting the importance of careful case selection and consideration of cumulative joint stress when performing repeated IA treatments (Beggan et al., 2025).

Concerns regarding repeated IAC administration have also been raised in human medicine, where repeated injections have been associated with measurable cartilage volume loss in patients with knee OA (Guermazi et al., 2020; McAlindon et al., 2017). A systematic review by Wernecke et al. (2015) highlighted conflicting results across trials, with some studies showing no radiographic progression and others showing measurable cartilage thinning and radiographic narrowing of joint space after repeated injections (Behrens et al., 1975; McAlindon et al., 2017; Moskowitz et al., 1970; Raynauld et al., 2003). This mirrors the concerns raised in equine literature, underscoring the importance of dosing, timing and careful patient selection to minimise adverse outcomes.

Evidence for pharmacodynamics and pharmacokinetics

The clinical effect of IACs is determined not only by their direct impact on inflammation and pain but also by their pharmacokinetics within the joint. In horses, TA remains detectable in synovial fluid for up to 2 weeks, whereas MPA persists for longer due to

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

its crystalline formulation, though with increased risk of adverse effects (Autefage et al., 1986; Chen et al., 1992; Kay et al., 2008; Soma et al., 2006). Pharmacokinetic studies have shown that TA concentrations decline to undetectable levels in the joint by 15 days post-injection, while methylprednisolone may remain present for up to 39 days because of its slower clearance rate (Autefage et al., 1986; Chen et al., 1992; Kay et al., 2008; Soma et al., 2006). TA has been shown to maintain chondrocyte and synoviocyte viability in culture, while MPA was associated with greater suppression of chondrocyte metabolic activity and increased synoviotoxicity in some models (McIlwraith, 2010; Sherman et al., 2015; Tokawa et al., 2025).

BM, commonly administered as betamethasone sodium phosphate and betamethasone acetate combinations, provides an intermediate duration of effect between TA and MPA. The dual-salt formulation allows for both rapid onset and sustained anti-inflammatory activity, making it a suitable option when prolonged action is desired without the extended persistence seen with MPA (McIlwraith & Lattermann, 2019). DEX, in contrast, exhibits rapid absorption and short intra-articular half-life, which may explain its less frequent use in equine joint therapy. Despite limited equine-specific pharmacokinetic data, DEX is thought to act primarily through strong glucocorticoid receptor activation, offering potent anti-inflammatory effects but little sustained joint residence time or long-term benefit (McIlwraith, 2010).

Collectively, the pharmacokinetic and pharmacodynamic profiles of these corticosteroids guide clinical decision-making in equine practice. Drugs with longer intra-articular retention, such as MPA, may provide extended pain relief but carry a higher risk of adverse cartilage effects, whereas agents like TA and BM achieve a balance between efficacy and safety. Understanding these distinctions is essential for tailoring corticosteroid selection to the specific joint, pathology and performance demands of the individual horse (McIlwraith, 2010; McIlwraith & Lattermann, 2019).

In human practice, similar pharmacological differences influence clinical decision-making. Rapidly acting corticosteroids are often preferred for short-term relief, while depot formulations may be reserved for joints requiring prolonged anti-inflammatory effects. The interplay of pharmacokinetics and pharmacodynamics emphasises that efficacy and safety are inseparable considerations in both equine and human joint management.

PRACTICAL CONSIDERATIONS AND RECOMMENDATIONS FOR CLINICAL PRACTICE

Selection of corticosteroid to minimise deleterious effects to cartilage

Among available intra-articular corticosteroids, TA has demonstrated reduced chondrotoxicity which has been reported in a model and dose-dependent fashion. For example, in vitro equine cartilage and synovial co-culture models stimulated with IL-1β demonstrated that TA, when used at clinically relevant concentrations, downregulates inflammatory and catabolic gene expression (including IL-1β and IL-6) without causing significant chondrocyte death, whereas other corticosteroids may demonstrate less favourable effects depending on dose and experimental conditions (Alvarez et al., 2020; Bolt et al., 2008; Dechant et al., 2003). Controlled experimental studies in an equine acute synovitis model showed that intra-articular TA significantly improved lameness scores, reduced synovial inflammation and normalised cartilage metabolism, supporting its clinical use and reputation in equine practice (Partridge et al., 2023). BM and DEX may provide short-term analgesia but are less frequently used due to inconsistent duration of effect and greater systemic absorption. In cases where end-stage OA and eventual ankylosis are expected, MPA may be used in clinical practice for its longer duration of analgesia. This approach is based on clinician experience rather than controlled evidence but reflects common practice management when cartilage preservation is no longer a therapeutic priority (McIlwraith, 2010; Trotter et al., 1991).

Timing of administration and rest period prior to exercise to minimise injury

The analgesic effects of intra-articular corticosteroids begin within hours. However, corticosteroids suppress synovial inflammation without repairing the underlying biomechanical tissue damage associated with OA, meaning that a horse returned too quickly to full exercise may overload weakened cartilage and subchondral bone with osseous defects or osteochondral fragmentation (McIlwraith & Lattermann, 2019). Rest may provide time for normalisation of synovial fluid composition and resolution of mechanical irritation, which may prolong the clinical effect. Experimental data performed in the equine osteochondral fragment model demonstrated that mechanical loading of an already compromised joint environment following IA TA injection may contribute to cartilage surface changes and subchondral alterations (Frisbie et al., 1997). However, direct evidence evaluating optimal rest duration following IAC administration in horses remains limited. Providing a short period of rest following injection is recommended in clinical practice to allow for resolution of synovial inflammation and restoration of joint homeostasis, although optimal duration has not been clearly defined. This rest not only improves safety but also prolongs the duration of clinical sign relief, in some cases extending clinical benefit by several additional weeks (Tokawa et al., 2025). In human sports medicine, similar findings have led to recommendations of 1–2 weeks of restricted loading following IA corticosteroid injections for knees and hips (Wernecke et al., 2015). However, in equine practice, when longer rest periods are not feasible, a shorter recovery window of 2–3 days is sometimes implemented to balance clinical practicality with patient welfare.

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Risk and frequency of repeated administration

The risk of negative effects increases with repeated injections. Studies in horses show that more than three to four corticosteroid injections per joint per year are associated with measurable declines in cartilage thickness and biomechanical integrity (Guermazi et al., 2020; Tokawa et al., 2025). Repeated synoviocentesis may also elevate the risk of joint sepsis following repeated needle introductions into the joint capsule. Systemic consequences such as hypothalamic–pituitary–adrenal (HPA) axis suppression and, in rare cases, corticosteroid-induced laminitis due to increased blood insulin concentrations also present rationales to limit excessive dosing (Boger et al., 2024; Hallowell et al., 2024; Page et al., 2024). For these reasons, corticosteroids should be integrated into broader management strategies rather than used as sole or long-term therapy. Adjunctive approaches such as nutritional supplementation (e.g., joint-support nutraceuticals), corrective farriery to optimise limb biomechanics, biological or viscosupplementary therapies to support joint homeostasis and structured conditioning to improve musculoskeletal support may all contribute to improved long-term management of OA. Epidemiologic data from Thoroughbred racehorses indicate that repeated intra-articular corticosteroid administration is associated with an increased hazard ratio for musculoskeletal injury, particularly when injections are performed within short intervals before high-speed exercise (Whitton et al., 2014). In that study, horses receiving multiple corticosteroid injections in the same joint had nearly twice the risk of subsequent musculoskeletal injury compared with those receiving a single treatment, although the authors noted that this likely reflected progression of underlying pathology rather than a direct drug effect. Consequently, the Horse Racing Integrity and Safety Authority (HISA) in the United States have adopted specific rules governing the use of IAC in racehorses. Based on current HISA regulations at the time of writing, any covered horses treated with any IAC injection of any joint shall not be permitted to perform a workout for 7 days following treatment or participate in a covered horserace for 14 days following treatment (Horseracing Integrity and Welfare Unit (HIWU), 2023). More precisely, any covered horses treated with any IAC injection of the metacarpophalangeal or metatarsophalangeal joint shall not be permitted to perform a workout for 14 days following treatment or participate in a covered horserace for 30 days following treatment. Updated guidelines from the American Association of Equine Practitioners (AAEP) similarly recommend judicious dosing, avoidance of routine 'maintenance injections' and individualised case-based decision-making to minimise long-term risk (AAEP, 2025).

Dosing in large vs. small joints

Intra-articular corticosteroid dosing in horses has been anecdotally determined by joint size and biomechanical load, although definitive in vivo dose titration studies are still lacking. Commonly implemented doses in larger joints such as the femorotibial or femoropatellar, carpal and metacarpophalangeal joints are typically 6–12 mg of TA for effective distribution, while clinical response in smaller joints such as the distal interphalangeal joint has been seen using lower doses (e.g., 2–4 mg) (Frisbie et al., 1997; McIlwraith et al., 2016). Current recommendations from the authors' practice emphasise tailoring doses to joint size rather than motion classification and using the lowest effective dose of TA to balance inflammation control with long-term joint health (Boorman et al., 2023).

Formulation characteristics also play a role in dosing decisions. Less soluble depot preparations such as MPA tend to remain localised within the joint, while TA may distribute more readily. As a result, clinicians often adjust dosing based on joint size and expected distribution to achieve adequate IA coverage (Cardone & Tallia, 2002; Frisbie et al., 1997; McIlwraith et al., 2016). Dilution with a balanced electrolyte solution (e.g., Lactated Ringer's) or hyaluronic acid can also alter IA retention and clearance characteristics rather than uniformly improving distribution, and in some cases may contribute to prolonged residence time or reflux of injectate from the joint (Machin et al., 2018). In line with findings from human sports medicine, equine practitioners are encouraged to use 'as much as necessary, as little as possible', to provide clinical relief appropriate to the joint size, while minimising cumulative cartilage and potential systemic risk (Guermazi et al., 2020; Wernecke et al., 2015).

Use in patients with endocrinopathies

The importance of endocrinopathies such as equine metabolic syndrome (EMS) and pituitary *pars intermedia* dysfunction (PPID) in the management of equine athletes has been a focus of recent research, and the presence of endocrinopathies should be considered when choosing to pursue corticosteroid therapy. EMS is characterised by abnormal insulin metabolism, including resting or post-prandial hyperinsulinaemia and tissue insulin resistance, and has been shown to affect 23% of sport horses (Hallowell et al., 2024). PPID, a neurodegenerative disorder that results in loss of inhibitory dopaminergic neurons and subsequent overproduction of pro-opiomelanocortin-derived peptides such as adrenocorticotrophic hormone (ACTH), can be found in 20% of horses over 15 years of age (Ireland & McGowan, 2018). Consequences of ACTH overproduction in untreated PPID horses include immunosuppression and insulin dysregulation. Both endocrinopathies have been highlighted as possible risk factors for corticosteroid-associated laminitis (McGowan et al., 2016), although literature demonstrating a causal relationship is lacking.

In relation to EMS, the propensity for corticosteroids to induce hyperinsulinaemia and tissue insulin resistance is of greatest concern. TA has been the most widely studied IA corticosteroid in this context and has been documented to cause significant increases in insulin for up to 5 days post-injection at a total body dose range of 9–18 mg (Boger et al., 2024; Hallowell et al., 2024; Page et al., 2024). No studies to date have examined the effects of

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TA in horses with confirmed EMS; however, one study has shown that horses with elevated basal insulin concentrations (>20 μIU/mL on hay-fed sample) had a more pronounced hyperinsulinemic response than those with normal basal insulin concentrations, with some individuals reaching peak insulin concentrations >200 μIU/mL following IA treatment with 18 mg TA (Hallowell et al., 2024). Studies in horses without EMS treated with 9 mg or 18 mg IA TA have found more modest peak insulin concentrations of 71 and 32 μIU/mL, respectively (Boger et al., 2024; Page et al., 2024). A single study has examined the impact of intra-articular betamethasone in a small number of horses with and without EMS and found a slight increase in mean insulin concentrations following treatment with a total body dose of 18 mg in both groups (Page, Rauber-Ramos, et al., 2025). Post-hoc power analysis in this study revealed it was underpowered to detect differences in insulin concentrations, so formal statistical analysis was not performed, and practitioners should use caution when drawing conclusions from these study results. The metabolic impact of MPA at a total body dose of 80 mg has been evaluated in a single study, and no significant increase in insulin was observed following treatment (Page, McPeek, et al., 2025). However, this study utilised the low end of the clinical dose range for MPA, and treated a small number of young geldings free of EMS and PPID. It is extremely important to recognise the limitations in extrapolating results from metabolically normal horses into the higher-risk EMS population, and from small populations of horses when significant individual variability in hormone response exists. Further research is needed to determine if the findings of the above studies hold true in larger populations of horses with confirmed EMS, and studies directly comparing multiple corticosteroids at equivalent total body doses are necessary to identify if a 'metabolically safer' treatment option exists.

The advent of point-of-care insulin readers has increased the accessibility of insulin measurement as an immediate screening tool to guide treatment decisions. It is important to note that single time-point insulin concentrations, particularly those on fasted patients, have been shown to be poorly sensitive for the diagnosis of EMS (Olley et al., 2019). In a recent study, fasted insulin concentrations diagnosed only 26% of horses later confirmed to have EMS based on an oral sugar test (Hallowell et al., 2024), and therefore dynamic insulin testing should be performed as described by the Equine Endocrinology Group (Bertin et al., 2024) in any horse where there is clinical concern for EMS prior to pursuing corticosteroid therapy. If this is not feasible, then a single-time-point insulin concentration at 1–2 h post-grain meal or while on pasture may be beneficial in determining risk. In patients with known EMS the fed-state insulin sample can also be useful in determining the patient's response to current management, but the authors caution against the use of corticosteroids in known EMS patients even if current insulin concentrations indicate control of disease. If corticosteroids are administered, practitioners should select the minimum effective dose at the lowest possible frequency. Patients should be closely monitored for foot soreness for 1–2 weeks post-injection, and stopping or reducing grain meals may be beneficial in reducing post-prandial insulin peaks (Palmer et al., 2025).

No studies to date have examined the impact of intra-articular corticosteroids on patients with PPID. The concerns above regarding exacerbating insulin dysregulation hold true for this patient population as well. Given that patients with uncontrolled PPID exist in a chronic state of immunosuppression, the hypothalamic–pituitary–adrenal axis suppression that occurs following corticosteroid treatment may be of additional concern. Suppression of cortisol and ACTH has been documented for 72–96 h post-TA (Hallowell et al., 2024; Page et al., 2024), 24–48 h post-betamethasone (Page, Rauber-Ramos, et al., 2025), and 12–120 h post-MPA (Page, Rauber-Ramos, et al., 2025; Soma et al., 2006). Given that unregulated PPID patients have a higher baseline risk of laminitis and infections, corticosteroids should be avoided in this population. In patients with PPID that is well-controlled both clinically and in terms of resting ACTH concentrations, it is unknown whether the risk of corticosteroid-associated laminitis is any greater than that of a healthy horse without PPID. Similar to patients with EMS, if corticosteroids are used in this population, they should be used at the minimum effective dose and frequency to reduce the risk of complications.

Adjunct and combination therapies

Corticosteroid injections are used alongside adjunct therapies to enhance efficacy and minimise risks associated with repeated steroid exposure. Hyaluronic acid (HA) remains the most commonly co-administered agent, potentially contributing to synovial viscosity, lubrication and chondroprotective effects (Neuenschwander et al., 2019). When combined with corticosteroids, HA was historically believed to extend clinical benefit and improve lameness outcomes. However, a multicentre clinical trial in horses found that TA alone achieved a higher short-term success rate (87.8%) compared with TA + HA (64.1%), suggesting that the addition of HA may not always provide added benefit (de Grauw et al., 2016).

More recently, orthobiologic and viscosupplementary therapies have gained traction for their potential to provide disease modification. Platelet-rich plasma (PRP) delivers concentrated growth factors, which promote extracellular matrix repair and reduce synovial inflammation. Interleukin-1 receptor antagonist protein (IRAP) specifically targets IL-1β and has shown clinical benefits in both equine and human osteoarthritis management. Mesenchymal stem cells (MSCs), derived from various sources including bone marrow, adipose tissue or blood, exhibit immunomodulatory and regenerative properties in experimental and clinical studies (Ardanaz et al., 2016; Kearney et al., 2022). Similarly, autologous blood-based products such as autologous conditioned serum (ACS) and autologous protein solution (APS) have been shown to influence inflammatory signalling pathways within equine cartilage and synovium (Alvarez et al., 2020; Usimaki et al., 2025). However, evidence evaluating the concurrent use of IAC and biologic therapies in horses remains limited. A recent

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

study investigating the combined use of TA and PRP demonstrated increased chondrocyte viability in vitro and enhanced short-term clinical outcomes compared to TA treatment alone, suggesting potential synergistic effects (Guidoni et al., 2024). However, this represents a single study with a relatively small sample size, and further research is required to establish the safety, efficacy and timing of combined therapies. In general, corticosteroids suppress inflammatory pathways that are also involved with cellular recruitment and activation, which could theoretically influence or suppress the activity of biologic therapies. Anecdotally, this has resulted in some clinicians recommending to delay biologic administration after corticosteroid use for a minimum of 2–12 weeks to allow for full clearance from the joint; however, further studies are necessary to fully explore the interaction of corticosteroids with biologic therapies.

In parallel, intra-articular polyacrylamide hydrogels (iPAAGs) (e.g., 2.5 or 4% formulations on the equine market at the time of writing) may represent novel adjunctive options for OA. Several recent narrative and systematic reviews have described the proposed mechanisms of action and clinical use of iPAAGs (Chow et al., 2026; Contino et al., 2026; McClure et al., 2024; Tnibar, 2025; Tnibar et al., 2015). The most clinically relevant consideration is the compatibility of iPAAGs with corticosteroid administration. 2.5% iPAAG are thought to act primarily through physical integration within the synovial membrane resulting in biomechanical stability and retention of normal joint capsule elasticity with minimal inflammatory response reported in histologic studies (Chow et al., 2026; Contino et al., 2026; Christensen et al., 2016; de Clifford et al., 2019). A pilot study did evaluate concurrent intra-articular administration of 2.5% PAAG (Arthramid®) and betamethasone esters in healthy horses. Each horse received 1 mL of 2.5% hydrogel and 1 mL of betamethasone (6 mg/mL) into the metacarpophalangeal joint. Across 30 days of follow-up, no adverse effects, lameness or joint effusion were reported, and clinical parameters remained stable or improved, indicating that the combination was well tolerated and may represent a safe adjunctive approach for managing joint inflammation (Whitaker et al., 2025). At time of writing, no studies to date have evaluated Noltrex® Vet (4% polyacrylamide hydrogel) in combination with corticosteroids; therefore, its use is typically reserved as a stand-alone therapy following reduction of synovial inflammation. So, while short-term concurrent administration appears safe, further studies are needed before evidence-based recommendations can be made regarding routine combination or sequencing strategies. Further research is also needed and ongoing to determine if the coadministration of corticosteroids and iPAAGs alters the pharmacokinetics of corticosteroids which would have important implications for corticosteroid withdrawal times.

Taken together, emerging adjunct therapies represent a paradigm shift in the approach to OA treatment from clinical sign suppression to joint preservation and potential disease modification. While corticosteroids remain available to provide rapid symptom/sign relief, implementing them as part of an integrated strategy with HA, orthobiologics or iPAAGs may provide immediate relief while reducing reliance on repeat injections as part of a long-term management strategy. Contemporary equine osteoarthritis management emphasises a multimodal approach, which highlights the benefits of integrating corticosteroids with biologics, as viscosupplementation, conditioning and workload modification rather than using them as sole long-term therapy (Goodrich & Nixon, 2006; McIlwraith, 2010). For practitioners, this multimodal approach reflects evolving best practice and aligns equine sports medicine with trends seen in human orthopaedics (McIlwraith & Lattermann, 2019; Wernecke et al., 2015).

CONCLUSIONS

Intra-articular corticosteroids continue to have a place in equine OA management, providing rapid relief from joint pain and inflammation. However, more recent evidence has elevated concerns related to contribution to cartilage damage, systemic sequelae and the consequences of repeated injections, prompting reevaluation of corticosteroid implementation in practice. Triamcinolone is frequently favoured in athletic horses based on current evidence supporting reduced chondrotoxicity; however, best practice across human and equine literature emphasises that corticosteroid selection should be individualised according to joint pathology, metabolic status, intended use and regulatory constraints, with multiple factors to consider. Use of the lowest effective dose and incorporation of an appropriate rest period after injection may reduce the risk of reinjury and/or extend the therapeutic window. Repeated injections should be limited and considered within the broader context of multimodal management, including nutrition, farriery, conditioning and adjunct biologic and viscosupplementary therapies to support long-term joint health.

Endocrinopathies should be considered and tested for in cases where there is clinical concern prior to corticosteroid treatment, given the risks of exacerbating hyperinsulinaemia and hypothalamic–pituitary–adrenal axis suppression with IAC. Corticosteroids should be avoided in patients with uncontrolled PPID and in those with confirmed EMS regardless of degree of clinical control. This individualised approach is supported by both equine and human data, underscoring the importance of balancing short-term clinical improvement with long-term joint preservation. Further research is needed in larger populations of horses with and without endocrinopathies to directly compare multiple corticosteroids at equivalent body doses and dosing intervals as much of the referenced literature does not permit direct comparison between studies.

In summary, IAC may remain a valuable treatment when used thoughtfully and in the context of other available evolving therapies for OA. Precision in corticosteroid selection and dosing, appropriate post-injection rest and integration with adjunctive treatments represent the foundation of modern evidence-based practice. Further high-quality prospective clinical studies are needed to define optimal dosing strategies and treatment intervals. Integration of corticosteroids with orthobiologics and novel biomaterials may define

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

the next generation of equine joint care, bridging rapid clinical sign control with long-term joint preservation.

AUTHOR CONTRIBUTIONS

K. Tanner: Writing – original draft; methodology. **L. Bass:** Conceptualization; methodology; supervision. **C. Kawcak:** Conceptualization; writing – review and editing; methodology; supervision. **L. V. Schnabel:** Writing – original draft; writing – review and editing; methodology. **K. L. Hallowell:** Writing – original draft; writing – review and editing; methodology. **L. M. Pezzanite:** Conceptualization; investigation; writing – original draft; writing – review and editing; methodology; project administration; supervision.

ACKNOWLEDGEMENTS

Open access publishing facilitated by Colorado State University in agreement with Wiley.

FUNDING INFORMATION

No funding was obtained for this article submission. Support for L. Pezzanite was provided by NIH K01OD037846-01A1.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest related to this report.

ETHICS STATEMENT

Not applicable for this review article.

ORCID

K. Tanner https://orcid.org/0009-0004-6609-0827
L. Bass https://orcid.org/0000-0003-3507-1450
C. Kawcak https://orcid.org/0000-0003-2401-9710
L. V. Schnabel https://orcid.org/0000-0002-1993-8141
K. L. Hallowell https://orcid.org/0009-0005-0999-1925
L. M. Pezzanite https://orcid.org/0000-0003-4990-5006

REFERENCES

Alvarez, A.V., Boone, L.H., Pondugula, S.R., Caldwell, F. & Wooldridge, A.A. (2020) Effects of autologous conditioned serum, autologous protein solution, and triamcinolone on inflammatory and catabolic gene expression in equine cartilage and synovial explants treated with IL-1β in co-culture. *Frontiers in Veterinary Science*, 7, 323. Available from: https://doi.org/10.3389/fvets.2020.00323

American Academy of Orthopaedic Surgeons (AAOS). (2021) *Management of osteoarthritis of the knee (non-arthroplasty). Evidence-based clinical practice guideline*. Rosemont, USA: AAOS. Available from: https://www.aaos.org/globalassets/quality-and-practice-resources/osteoarthritis-of-the-knee/oak3cpg.pdf

American Association of Equine Practitioners (AAEP). (2025) *Clinical guidelines for the use of intra-articular corticosteroids in horses. AAEP practice committee report*. Available from: https://aaep.org/resource/position-on-the-use-of-corticosteroids/

Ardanaz, N., Vázquez, F.J., Romero, A., Remacha, A.R., Barrachina, L., Sanz, A. et al. (2016) Inflammatory response to the administration of mesenchymal stem cells in an equine experimental model: effect of autologous, and single and repeat doses of pooled allogenic cells in healthy joints. *BMC Veterinary Research*, 12, 65. Available from: https://doi.org/10.1186/s12917-016-0692-x

Autefage, A., Alvinerie, M. & Toutain, P.L. (1986) Synovial fluid and plasma kenetics of methylprednisolone and methylprednisolone acetate in horses following intra-articular administration of methylprednisolone acetate. *Equine Veterinary Journal*, 18(3), 193–198. Available from: https://doi.org/10.1111/j.2042-3306.1986.tb03594.x

Beggan, C.P., Quinn, G.C. & McIlwraith, C.W. (2025) Medial femorotibial and femoropatellar articular cartilage delamination following intra-articular therapy with triamcinolone and gentamicin in five yearlings. *Equine Veterinary Education*, 37, 1–9. Available from: https://doi.org/10.1111/eve.14176

Behrens, F., Shepard, N. & Mitchell, N. (1975) Alterations of rabbit articular cartilage by intra-articular injections of glucocorticoids. *The Journal of Bone & Joint Surgery*, 57(1), 70–76.

Benzon, H.T., Provenzano, D.A., Nagpal, A., Souza, D., Eckmann, M.S., Nelson, A.M. et al. (2025) Use and safety of corticosteroid injections in joints and musculoskeletal soft tissue: guidelines from the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, the American Society of Interventional Pain Physicians, and the International Pain and Spine Intervention Society. *Regional Anesthesia and Pain Medicine*, 12, rapm-2024-105656. Available from: https://doi.org/10.1136/rapm-2024-105656

Bertin, F.R., Bailey, S., Burns, T., de Laat, M., Durham, A., Frank, N. et al. (2024) *Recommendations for the diagnosis and management of equine metabolic syndrome (EMS) and insulin dysregulation*. North Grafton: Equine Endocrine Group. Available from: https://equineendocrinologygroup.org/s/Final-Oct-2024-EEG-EMS-ID-Recommendations.pdf

Boger, B.L., Manfredi, J.M., Loucks, A.R., Salamey, M.Z., Kapeller, L.E., Fricano, A.G. et al. (2024) Intra-articular triamcinolone acetonide inection results in increases in systemic insulin and glucose concentrations in horses without insulin dysregulation. *Equine Veterinary Journal*, 56(2), 326–331. Available from: https://doi.org/10.1111/evj.14003

Bolt, D.M., Ishihara, A., Weisbrode, S.E. & Bertone, A.L. (2008) Effects of triamcinolone acetonide, sodium hyaluronate, amikacin sulfate, and mepivacaine hydrochloride, alone and in combination, on morphology and matrix composition of lipopolysaccharide-challenged and unchallenged equine articular cartilage explants. *American Journal of Veterinary Research*, 69(7), 861–867. Available from: https://doi.org/10.2460/ajvr.69.7.861

Boorman, S., McMaster, M.A., Groover, E. & Caldwell, F. (2023) Review of glucocorticoid therapy in horses: intra-articular corticosteroids. *Equine Veterinary Education*, 35, 327–336. Available from: https://doi.org/10.1111/eve.13719

Cardone, D.A. & Tallia, A.F. (2002) Joint and soft tissue injection. *American Family Physician*, 66(2), 283–288.

Chen, C.L., Sailor, J.A., Collier, J. & Wiegand, J. (1992) Synovial and serum levels of triamcinolone following intra-articular administration of triamcinolone acetonide in the horse. *Journal of Veterinary Pharmacology and Therapeutics*, 15(3), 240–246. Available from: https://doi.org/10.1111/j.1365-2885.1992.tb01012.x

Chow, L., Contino, E., Seabaugh, K., Goodrich, L., McIlwraith, C.W., Impastato, R. et al. (2026) Intra-articular 2.5% polyacrylamide hydrogel alters synovial immune pathways in equine experimental osteoarthritis. *American Journal of Veterinary Research* (in press).

Christensen, L., Camitz, L., Illigen, K., Hansen, M., Sarvaa, R. & Conaghan, P. (2016) Synovial incorporation of polyacrylamide hydrogel after injection into normal and osteoarthritic animal joints. *Osteoarthritis and Cartilage*, 24, 1999–2002. Available from: https://doi.org/10.1016/j.joca.2016.07.007

Contino, E.K., AbuAlia, M.J., Nelson, B.B., Goodrich, L.R., Barrett, M.F., King, M.R. et al. (2026) Intra-articular 2.5% polyacrylamide hydrogel demonstrates disease-modifying effects in an experimental

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

model of equine osteoarthritis. *Journal of the American Veterinary Medical Association* (in press).

de Clifford, L.T., Lowe, J.N., Mckellar, C.D. & Bolwell, C. (2019) Use of a 2.5% cross-linked polyacrylamide hydrogel in the management of joint lameness in a population of flat-racing thoroughbreds: a pilot study. *Equine Veterinary Education*, 77, 57–62. Available from: https://doi.org/10.1016/j.jevs.2019.02.012

de Grauw, J.C., Visser-Meijer, M.C., Lashley, F., Meeus, P. & van Weeren, P.R. (2016) Intra-articular treatment with triamcinolone compared with triamcinolone with hyaluronate: a randomised open-label multicentre clinical trial in 80 lame horses. *Equine Veterinary Journal*, 48(2), 152–158. Available from: https://doi.org/10.1111/evj.12383

Dechant, J.E., Baxter, G.M., Frisbie, D.D., Trotter, G.W. & McIlwraith, C.W. (2003) Effects of dosage titration of methylprednisolone acetate and triamcinolone acetonide on interleukin-1-conditioned equine articular cartilage explants in vitro. *Equine Veterinary Journal*, 35, 444–450. Available from: https://doi.org/10.2746/042516403775600479

Frisbie, D.D., Kawcak, C.E., Trotter, G.W., Powers, B.E., Walton, R.M. & McIlwraith, C.W. (1997) Effects of triamcinolone acetonide on an in vivo equine osteochondral fragment exercise model. *Equine Veterinary Journal*, 29(5), 349–359. Available from: https://doi.org/10.1111/j.2042-3306.1997.tb03138.x

Goodrich, L.R. & Nixon, A.J. (2006) Medical treatment of osteoarthritis in the horse – a review. *Veterinary Journal*, 171(1), 51–69. Available from: https://doi.org/10.1016/j.tvjl.2004.07.008

Guermazi, A., Neogi, T., Katz, J.N., Kwoh, K., Conaghan, P.G., Felson, D.T. et al. (2020) Intra-articular corticosteroid injections for the treatment of hip and knee osteoarthritis-related pain: considerations and controversies with a focus on imaging. *Radiology*, 294(3), 503–515. Available from: https://doi.org/10.1148/radiol.2020200771

Guidoni, K., Chiaradia, E., Pepe, M., Di Meo, A., Tognoloni, A., Seccaroni, M. et al. (2024) The combined use of triamcinolone and platelet-rich plasma in equine metacarpophlangeal joint osteoarthritis treatments: an in vivo and in vitro study. *Animals (Basel)*, 14(24), 3645. Available from: https://doi.org/10.3390/ani14243645

Hallowell, K.L., Dembek, K., Horne, C.R., Knych, H.K., Messenger, K.M. & Schnabel, L.V. (2024) Systemic absorption of triamcinolone acetonide is increased from intrasynovial versus extrasynovial sites and induces hyperglycemia, hyperinsulinemia, and suppression of the hypothalamic-pituitary-adrenal axis. *Frontiers in Veterinary Science*, 11, 1388470. Available from: https://doi.org/10.3389/fvets.2024.1388470

Hallowell, K.L., Horne, C.R., Miller, C.S., Tufts, S.R., Dembek, K., Love, K.R. et al. (2026) Prevalence of insulin dysregulation in a sport horse population as determined by traditional and stall-side testing. *Equine Veterinary Journal* (in press). Available from: https://doi.org/10.1002/evj.70204

Hollander, J.L., Brown, E.M., Jessar, R.A. & Brown, C.Y. (1951) Hydrocortisone and cortisone injected into arthritic joints. *Journal of the American Medical Association*, 147(17), 1629–1635. Available from: https://doi.org/10.1001/jama.1951.03670340019005

Horseracing Integrity and Welfare Unit (HIWU). (2023) *Attending Veterinarian Handbook*. Lexington: Horseracing Integrity and Safety Authority. Available from: https://traoracing.com/PDF/HISA/AttendingVetHandbook-jul8.pdf

Ireland, J.L. & McGowan, C.M. (2018) Epidemiology of pituitary pars intermedia dysfunction: a systematic literature review of clinical presentation, disease prevalence and risk factors. *The Veterinary Journal*, 235, 22–33. Available from: https://doi.org/10.1016/j.tvjl.2018.03.002

Kawcak, C.E., Norrdin, R.W., Frisbie, D.D., Trotter, G.W. & McIlwraith, C.W. (1998) Effects of osteochondral fragmentation and intra-articular triamcinolone acetonide treatment on subchondral bone in the equine carpus. *Equine Veterinary Journal*, 30, 66–71. Available from: https://doi.org/10.1111/j.2042-3306.1998.tb04090.x

Kay, A.T., Bolt, D.M., Ishihara, A., Rajala-Schultz, P.J. & Bertone, A.L. (2008) Anti-inflammatory and analgesic effects of intra-articular injection of triamcinolone acetonide, mepivacaine hydrochloride, or both on lipopolysaccharide-induced lameness in horses. *American Journal of Veterinary Research*, 69(12), 1646–1654. Available from: https://doi.org/10.2460/ajvr.69.12.1646

Kearney, C.M., Khatab, S., van Buul, G.M., Plomp, S.G.M., Korthagen, N.M., Labberté, M.C. et al. (2022) Treatment effects of intra-articular allogenic mesenchymal stem cells in equine joint disease. *Frontiers in Veterinary Science*, 9, 907616. Available from: https://doi.org/10.3389/fvets.2022.907616

Kolasinski, S.L., Neogi, T., Hochberg, M.C., Oatis, C., Guyatt, G., Block, J. et al. (2019) American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hip and knee. *Arthritis Care and Research*, 71, 149–162. Available from: https://doi.org/10.1002/acr.24131

Machin, J., Duer, W., Maylin, G., Fenger, C., Wilson, D., Ivey, M. et al. (2018) Variability in plasma concentrations of methylprednisolone 6 days after intrasynovial injection of methylprednisolone acetate in racing horses: a field study. *Equine Veterinary Journal*, 51, 343–348. Available from: https://doi.org/10.1111/evj.13003

Manfredi, J.M., Jacob, S. & Norton, E. (2023) A one-health lens offers new perspective on the importance of endocrine disorders in the equine athlete. *Journal of the American Veterinary Medical Association*, 261(2), 151–164. Available from: https://doi.org/10.2460/javma.22.11.0485

McAlindon, T.E., LaValley, M.P., Harvey, W.F., Price, L.L., Driban, J.B., Zhang, M. et al. (2017) Effect of intra-articular triamcinolone vs saline on knee cartilage volume and pain in patients with knee osteoarthritis a randomized clinical trial. *Journal of the American Medical Association*, 317(19), 1967–1975. Available from: https://doi.org/10.1001/jama.2017.5283

McClure, S.R., Peitzmeier, M.D., Jackman, B.R., Evans, R.B., Ziegler, C.L., Ganta, C.K. et al. (2024) Serial intra-articular injections of 4% polyacrylamide hydrogel cause no detrimental effects in equine joints. *American Journal of Veterinary Research*, 23(85), 275–284. Available from: https://doi.org/10.2460/ajvr.24.01.0016

McGowan, C., Cooper, D. & Ireland, J. (2016) No evidence that therapeutic systemic corticosteroid administration is associated with laminitis in adult horses without underlying endocrine or severe systemic disease. *Veterinary Evidence*, 1, 1–17. Available from: https://doi.org/10.18849/ve.v1i1.12

McIlwraith, C.W. (2010) The use of intra-articular corticosteroids in the horse: what is known on a scientific basis. *Equine Veterinary Journal*, 42, 563–571. Available from: https://doi.org/10.1111/j.2042-3306.2010.00095.x

McIlwraith, C.W., Frisbie, D.D., Kawcak, C.E. & van Weeren, P.R. (2016) *Joint disease in the horse*, 2nd edition. St. Louis: Elsevier.

McIlwraith, C.W. & Lattermann, C. (2019) Intra-articular corticosteroids for knee pain – what have we learned from the equine athletes and current best practice. *The Journal of Knee Surgery*, 32, 9–25. Available from: https://doi.org/10.1055/s-0038-1676449

Moskowitz, R.W., Davis, W., Sammarco, J., Mast, W. & Chase, S.W. (1970) Experimentally induced corticosteroid arthopathy. *Arthritis & Rheumatism*, 13(3), 236–243. Available from: https://doi.org/10.1002/art.1780130304

Murray, R.C., DeBowes, R.M., Gaughan, E.M., Zhu, C.F. & Athanasiou, K.A. (1998) The effects of intra-artiular methylprednisolone and exercise on the mechanical properties of articular cartilage in the horse. *Osteoarthritis and Cartilage*, 6, 106–114. Available from: https://doi.org/10.1053/joca.1997.0100

Neuenschwander, H.M., Moreira, J.J., Vendruscolo, C.P., Machado, T.S.L. & Alves, A.L.G. (2019) Hyaluronic acid has chondroprotective and joint-preserving effects on LPS-induced synovitis in horses. *Journal of Veterinary Science*, 20(6), e67. Available from: https://doi.org/10.4142/jvs.2019.20.e67

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Olley, R.B., Carslake, H.B., Ireland, J.L. & McGowan, C.M. (2019) Comparison of fasted basal insulin with the combined glucose-insulin test in horses and ponies with suspected insulin dysregulation. *Veterinary Journal*, 252, 105351. Available from: https://doi.org/10.1016/j.tvjl.2019.105351

Page, A.E., Johnson, M., Parker, J.L., Jacob, O., Poston, R., Adams, A.A. et al. (2024) The effects of intra-articular triamcinolone and autologous protein solution on metabolic parameters in horses. *Animals*, 14(15), 2250. Available from: https://doi.org/10.3390/ani14152250

Page, A.E., McPeek, J.L., Carattini, S., McGreevy, E. & Adam, E. (2025) Intra-articular methylprednisolone acetate does not induce hyperinsulinemia or hyperglycemia in metabolically normal horses. *Journal of the American Veterinary Medical Association*, 10, 1–6. Available from: https://doi.org/10.2460/javma.25.08.0566

Page, A.E., Rauber-Ramos, A.M., Humiston, M., McPeek, J.L. & Adam, E.N. (2025) Initial investigation into the metabolic effects of intra-articular betamethasone on normal and insulin dysregulated horses. *Journal of Equine Veterinary Science*, 147, 105404. Available from: https://doi.org/10.1016/j.jevs.2025.105404

Palmer, A.T., Watts, M.R., Timko, K.J., Pinnell, E.F., Keefer, K.A., Gorman, O. et al. (2025) Corticosteroid administration enhances the glycemic, insulinemic, and incretin responses to a high-protein mixed meal in adult horses. *Journal of Veterinary Internal Medicine*, 39(2), e17305. Available from: https://doi.org/10.1111/jvim.17305

Partridge, E., Adam, E., Wood, C., Parker, J., Johnson, M., Horohov, D. et al. (2023) Residual effects of intra-articular betamethasone and triamcinolone acetonide in an equine acute synovitis model. *Equine Veterinary Journal*, 55(5), 905–915. Available from: https://doi.org/10.1111/evj.13899

Pezzanite, L., Chow, L., Piquini, G., Griffenhagen, G., Ramirez, D., Dow, S. et al. (2021) Use of in vitro assays to identify antibiotics that are cytotoxic to normal equine chondrocytes and synovial cells. *Equine Veterinary Journal*, 53(3), 579–589. Available from: https://doi.org/10.1111/evj.13314

Raynauld, J.P., Buckland-Wright, C., Ward, R., Choquette, D., Haraoui, B., Raynauld, J.P. et al. (2003) Safety and efficacy of long-term intraarticular steroid injection in osteoarthritis of the knee: a randomized, double-blind, placebo-controlled trial. *Arthritis and Rheumatism*, 48(2), 370–377. Available from: https://doi.org/10.1002/art.10777

Sherman, S.L., Khazai, R.S., James, C.H., Stoker, A.M., Flood, D.L. & Cook, J.L. (2015) In vitro toxicity of local anesthetics and corticosteroids on chondrocyte and Synoviocyte viability and metabolism. *Cartilage*, 6(4), 233–240. Available from: https://doi.org/10.1177/1947603515594453

Soma, L.R., Uboh, C.E., Luo, Y., Guan, F., Moate, P.J. & Boston, R.C. (2006) Pharmacokinetic of methylprednisolone acetate after intra-articular administration and its effect on endogenous hydrocortisone and cortisone secretion in horses. *American Journal of Veterinary Research*, 67(4), 654–662. Available from: https://doi.org/10.2460/ajvr.67.4.654

Tnibar, A. (2025) Review of intra-articulated 2.5% polyacrylamide hydrogel, a new concept in management of osteoarthritis. *Equine Veterinary Education*, 37, 161–168. Available from: https://doi.org/10.1111/eve.14087

Tnibar, A., Schougaard, H., Camitz, L., Rasmussen, J., Koene, M., Jahn, W. et al. (2015) An international multi-centre prospective study on the efficacy of an intra-articular polyacrylamide hydrogel in horses with osteoarthritis: a 24-month follow-up. *Acta Veterinaria Scandinavica*, 57, 20. Available from: https://doi.org/10.1186/s13028-015-0110-6

Tokawa, P.K.A., Baccarin, R.Y.A. & Zanotto, G.M. (2024) Intra-articular corticosteroids: systematic review of effects on osteoarthritis and joint health. *Equine Veterinary Education*, 37, 371–381. Available from: https://doi.org/10.1111/eve.14097

Tokawa, P.K.A., Baccarin, R.Y.A. & Zanotto, G.M. (2025) Intra-articular corticosteroids: systematic review of effects of multiple injections and different doses. *Equine Veterinary Education*, 37, 522–531. Available from: https://doi.org/10.1111/eve.14098

Trotter, G.W., McIlwraith, C.W., Yovich, J.V., Norrdin, R.W., Wrigley, R.H. & Lamar, C.H. (1991) Effects of intra-articular administration of methylprednisolone acetate on normal equine articular cartilage. *American Journal of Veterinary Research*, 52, 83–87.

Usimaki, A., Ciamillo, S.A., Barot, D., Linardi, R.L., Engiles, J.B. & Ortved, K.F. (2025) Single injection of intra-articular autologous protein solution (APS) in horses with IL-1β-induced synovitis. *Equine Veterinary Journal*, 57, 806–816. Available from: https://doi.org/10.1111/evj.14203

Wernecke, C., Braun, H.J. & Dragoo, J.L. (2015) The effect of intra-articular corticosteroid on articular cartilage: a systematic review. *Orthopaedic Journal of Sports Medicine*, 3, 2325967115581163. Available from: https://doi.org/10.1177/2325967115581163

Whitaker, B., Barnhard, J.A., Webb, K.R., Levine, D., Green, M.M. & Vieira, M.R. (2025) The concurrent use of 2.5% polyacrylamide hydrogel and betamethasone esters for intra-articular injection is well tolerated in 10 healthy horses. *Journal of the American Veterinary Medical Association*, 263, 460–467. Available from: https://doi.org/10.2460/javma.24.10.0651

Whitton, R.C., Jackson, M.A., Campbell, A.J.D., Anderson, G.A., Parkin, T.D.H., Morton, J.M. et al. (2014) Musculoskeletal injury rates in thoroughbred racehorses following local corticosteroid injection. *Equine Veterinary Journal*, 200, 71–76. Available from: https://doi.org/10.1016/j.tvjl.2013.09.003

Zanotto, G.M. & Frisbie, D.D. (2021) Current joint therapy usage in equine practice: changes in the last 10 years. *Equine Veterinary Journal*, 54, 750–756. Available from: https://doi.org/10.1111/evj.13489

How to cite this article: Tanner, K., Bass, L., Kawcak, C., Schnabel, L.V., Hallowell, K.L. & Pezzanite, L.M. (2026) Updates on intra-articular corticosteroid administration in horses. *Equine Veterinary Education*, 00, 1–11. Available from: https://doi.org/10.1111/eve.70132

20423292, 0, Downloaded from https://beva.onlinelibrary.wiley.com/doi/10.1111/eve.70132 by Colorado State University, Wiley Online Library on [31/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License