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Assessing Acute Pain in Horses Statistically Using a Facial Expression: An In-Depth Analysis

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Abstract

The evaluation of pain is of crucial significance in monitoring the well-being and overall quality of life in horses. Although essential, more research is needed that focuses on pain scales particularly designed for the goal evaluation of pain in young horses. Face gestures can be used to measure severe discomfort in neonatal animals, as shown by previous studies conducted in other species. To overcome this, the current study attempted to modify the "EQUUS-FAP FOAL (Equine Utrecht University Scale for Facial Assessment of Pain in Foals (F))", a face gestures discomfort hierarchy that was produced for mature horses, to enable significant pain assessment in foals. The seventy foals in the study, 30 sufferers with acute pain issues and 40 healthy controls were subjected to the "EQUUS-FAP FOAL" scale. Three observers who were blinded to the foals' videos, which lasted between 40 to 70 seconds, evaluated them. Acute medical conditions were identified in sufferer by clinical examination and further diagnostic tests. The scale's intra and inter-observer reliability was evaluated with Cronbach's alpha. With Cronhbach's alpha values of 0.96 and 0.97, respectively, "EQUUS-FAP FOAL" showed strong intra and inter-observer reliability ($p < 0.001$). Sufferer pain scores were greater than those of healthy controls ($p < 0.001$) and they were lower after receiving intravenous flunixin meglumine or meloxicam, two Non-Steroidal Anti-Inflammatory Drug (NSAID) treatments($p < 0.05$). The results of this study provide support for the effectiveness of the facial expression-based "EQUUS-FAP FOAL" pain hierarchy for assessing acute pain in foals.

Keywords: Acute Pain, Facial Expression, Horses, EQUUS-FAP FOAL IRAO (Intra observer), IRO (Inter observer)

INTRODUCTION

Acute pain in horses is a serious condition that needs to be treated with caution and quickly. For veterinary professionals, equine caregivers and anybody else involved in the welfare of these amazing creatures, that are able to identify and comprehend pain in horses is essential. Reading a horse's facial expressions can be an interesting method of determining how much pain they are in because it offers a nonverbal, subtle window into their agony (1).

Similarly, horses feel pain when they are hurt, ill, or have different medical issues. Horses are unable to express their pain vocally, which makes it difficult for caregivers to recognize and alleviate their suffering. Assessing a horse's discomfort accurately and promptly is essential because, if left untreated, it can worsen and potentially cause negative behavioral changes (2).

Horses' face gesture can be a handy indicator of their level of pain. Horses' complex jaw tissues are diverse, that are used to express their emotional and physical situations discreetly. By analyzing these emotions, researchers and

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equestrian specialists have been able to pinpoint particular signs that are associated with acute pain. By being aware of these subtleties, caregivers can intervene to improve the horse's general well-being (3).

Overall, body language is essential in evaluating pain in horses. A horse in acute pain can adopt abnormal postures, such as shifting its weight from one leg to another or adopting a stance that relieves pressure on a painful area. Unusual behaviors like pawing the ground or repeatedly lying down and getting up, can be indicative of pain. It is crucial for horse owners, trainers as well as veterinarians to be vigilant that familiarize themselves with these facial expressions and behaviors associated with acute pain (4). Early detection allows for timely intervention, reducing the potential for further complications and promoting the well-being of the horse. Regular observation, combined with a thorough understanding of equine pain indicators, contributes to effective pain management as well as ensures the overall health and happiness of these magnificent animals (5).

Study (6) evaluated the way dental disorders impact the welfare of horses by using the Horse Grimace Scale (HGS) to evaluate the foal gesture. Thirty-three adult horses, male and female, who regularly took part in working or sports activities, had their six distinct facial characteristics evaluated tense nose with flattening of the profile, prominently tense jaw muscles, orbital tightening, ears held stiffly backwards and mouth strained with pronounced chin.

The study (7) established the probability to apply the HGS to analyzed pain deals with dental problems, proving that HGS was a dependable as well as repeatable method for the assessment and monitoring treatment-related improvement.

The paper (8) examined the credibility and clinical application of two pain scales, the equine EQUUS-FAP and the Composite Pain Scale (CPS). Seventy-seven adult horses were used in cohort follow-up research. Two separate examiners were seen directly to evaluate synthesized and levels of pain according to emotion. They found that every horse was examined upon arrival, as well as the first and second-days following surgery or arrival.

The paper (9) expressed the range in facial form in female Japanese macaques that had experimental laparotomies using Geometric Morphometrics (GMM). Videos of fourteen macaques were used to capture face image samples prior to surgery as well as one, three and seven days following the treatment. Pre-operative image samples were deemed painless and after surgery, facial expressions were examined for possible signs of discomfort.

The paper (10) examined the protocol that was registered and the PRISMA fundamentals were followed in reporting the study. Included studies were detailing the creation, verification and evaluation of grimace scales' measuring capabilities. Two investigators carried out the extraction and evaluation of the information in compliance with recommendations provided by the Regulations for the adaptation of Medical Monitoring Equipment, which depend on consent.

The paper (11) explained that measurement characteristics of grimace measures include gaps in knowledge, as the systematic study had explained and enhanced equipment development, enhanced statistical analysis along with the applying grimace scale to quantify agony in nonhuman beings should be the main areas of future research.

The study (12) explained the expressions that, free of pain, healthy horses make before, during and after transportation coupled with social isolation, two seemingly distressing yet common management practices are described. A total of twenty-eight horses were transported in a horse trailer by short-distance road transport.

The study (13) described that resulted in the creation and initial validation of the Equine Ophthalmic Pain Scale (EOPS), a combined pain rating system used to assess eye pain in horses. A selection of eye pain indicators was made and they were categorized as behavioral, physiological, or ocular manifestations. Eight horses were included

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in the study (group P) after being diagnosed with ocular or ADNEXA disorders that required to be dealt with on a medical basis or on the basis of surgery.

The study (14) explained the degree to which equine actions and facial expressions were linked to action asymmetry as well as recognized behavioral combinations along with feelings that appeared in horses that caused discomfort in the musculature. Based on these outcomes, a live diagnostic tool for lower orthopedic pain should contain five body behaviors interactive behavior, attention, placement in the box stall, posture and head position.

The article (15) examined the development and testing of two pain scales for use with donkeys experiencing acute pain was presented in the study. Their findings illustrated that low-grade inflammatory pain could not be identified by the five techniques for statistics applied to the analysis of the face of horse.

The study (16) investigated whether horses experiencing discomfort during under-skin polylactide-based polymer implantation. Five techniques for statistics, including both established and novel ones, were applied to analyze FE. They first scored each of the seven FEs independently. The ratings of the seven FEs were totaled. Analyzing the principal components (PCA**)** was carried out using the seven FE ratings that were acquired using the first technique. Next, using the contribution variability of each variable from the PCA, weights were calculated for each FE. Finally, they gave the animals' faces a general score (GFS).

The paper (17) described the procedure for creating a "proof of idea" technique to identify feelings in equines. There were two components to the system a detector and a prototype. A quick region-based convolutional neural network was used as the detector to identify horses in an illustration. The convolutional neural network model was used to forecast the horses' feelings. They implied that while observers can be able to discern the subject's emotions, the authenticity of those feelings could be obscured by interpretation. Emotions were experienced by animals in a similar manner that can be equally challenging to identify.

The study (18) investigated 90 racing horses. Individual parasite egg counts in their feces were compared to the horses' welfare. The horses were naturally infected with gastrointestinal parasites while living on a stud farm in southern Brazil. For a period of 12 months, welfare and FEC assessments were conducted on a monthly basis.

The study (19) explained comprehensively the alterations in facial activity in eight horses that were at rest and progressed from sound to mild orthopedic discomfort caused by Lipo Poly Saccharides (LPS) injected into the tarsocraral joint. Objective gait analysis was used to quantify the progression and regression of lameness during movement and EquiFACS was used to describe the facial activity of the horses in video sequences collected while the horses were resting in their box stalls. The aim of the current study modified the face gestures discomfort hierarchy known as the "EQUUS-FAP FOAL (Equine Utrecht University Scale for Facial Assessment of Pain in Foals (F))", which was originally created for senior horses.

MATERIALS AND METHODS

Seventy foals (30 Sufferers and 40 healthy control animals) were evaluated at various sites. The sufferer, who was identified by attending vets from different facilities in India as having health problems causing excruciating pain, was accompanied by our mother. This study did not include foals without their mare or those with compromised mental condition. A control group of healthy, clinically normal foals was selected to be added to the injured group.

A group of matured F (16 days – 7 months) and a group of neonatal F(0-15 days) were created from both sick and control foals (Table (1)). We got every owner's written informed consent. The foals were left unrestrained

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and uncontrolled in a stable with our dam during the video filming of the participants to lessen the chance that stress and/or distraction might alter their facial expressions. We had video snippets ranging from 40 to 70 seconds because our mare occasionally had offspring hiding behind her. The observers' window of opportunity to see the foals this time was standardized at 40 seconds.

Table (1). The Data of F (Source: Author)

Parameter	Sufferer	Controls
Neonatal F		
Total	15	19
Mean (SD)	11.6 ± 4.5	5.5 ± 2.7
No of colts	7	9
No of fillies	8	10
Mature F		
Total	15	21
Mean (SD)	103.9 ± 40.1	113.2 ± 40.8
No of colts	6	11
No of fillies	9	10
Total no of F	30	40

The video was taken by the person who, outside the box, used their smartphone's camera to record the footage. The people who purchased the videos were either students or practicing veterinarians. Sufferers were videotaped at various intervals, including right before and 1-3 hours after receiving NSAID analgesic therapy. Videos were randomized and blindfolded. Six observers (two senior anesthetists and four veterinary master students) performed video observations while blind to the patient's conditions and analgesic treatment plans. They used the “EQUUS-FAP FOAL” pain scale.

Over three days, the pupil received short instructions from their supervisor, a senior anesthetist, using a variety of images and videos of foals and adult horses that were left out of the research. The learners randomly selected and observed each video again, three weeks apart, with the goal to assess IRAO agreement. With a few minor modifications, the “EQUUS-FAP FOAL” is according to the “EQUUS-FAP” for matured equines. Originally, the criteria "eyelids" did not include the visibility of the sclera because preliminary observations showed that a large number of pain-free, healthy F displayed their sclera.

Furthermore, as many foals exhibited the behavior in situations without pain, the facial gesture unit "flehmen" was eliminated. They included the facial gestures unit in the pain hierarchy after seeing lip-smacking in foals in pilot observations that were experiencing acute pain. The pain score comprised discrete facial expressions for groaning, yawning and gnashing teeth. The senior anesthetist who worked on the study developed those modifications. Before the study began, 20 foals that were not included in it had tested the new ethogram.

Making use of a scorecard filled out throughout the video observations, the pain scores were assigned. Independent samples T-tests were used to compare the sufferer ages and the monitored foals yet Pearson Chi-square analyses were employed to assess the sex distribution of the sufferer and control foals. The median and quartiles are used to express the pain rating data. Intra Class Correlation (ICC) analysis was used to measure IRAO and IRO agreement for overall pain values. Mann Whitney U tests were used to assess differences between sufferer and controls, as well

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as between newborn along with older control foals. The Wilcoxon signed-rank test was used to compare pain ratings in twelve sufferers before and 1-3 hours after NSAID administration. By using ROC (Receiver Operating Characteristic) analysis, threshold amounts on the pain scales that allowed for the separation of sufferer from control animals were established and sensitivity as well as specificity was computed. IBM's SPSS version 22.0 was a commercial program used for statistical analysis. At$p < 0.05$, statistically significant was deemed acceptable.

RESULT

In comparison to the neonatal control F, the age of the neonatal patient F was greater ($p < 0.01$) however; there was minor variance in age between the matured F($p = 0.5$) and the untreated foals. In younger ($p = 0.35$) and matured ($p = 0.08$) F, between sufferer and the controls, there was no significant variation in the sex distribution. The correlation analysis between the six independent observers' overall pain values is displayed in Table (2) [A] and [B]. For every foal taken as a whole, there was strong and significant IRAO agreement and strong IRO agreement. When comparing neonatal foals to older foals, IRO agreement was better for the former. There were no variations in pain levels between newborn and older control foals ($p = 0.62$). Sufferer ' pain scores were greater than those of control animals for older and neonatal F, additionally for all of the categories as a whole ($p < 0.001$ for every group) (Figure (1)). After NSAIDs were administered, pain scores decreased $(p < 0.05)$ (Figure (2)). The sensitivity and specificity of "EQUUS-FAP FOAL" were 91% and 84.6%, respectively, when used with a threshold value of > 3 to distinguish among the well-controlled horses and the ill ones. The distribution of optimistic values in terms of frequency for each expression on the face unit in the "EQUUS-FAP FOAL" is displayed in Figure (3). The following specific facial action units showed significant variations in positive scores between the patient and control groups head, eye lashes, focus, mouth edges, tone of muscles, lip-smacking and ears. Images of a Warmblood colt newborn, nine days old treated surgically for a proximal phalanx fracture are shown in Figure (4). The "EQUUS-FAP FOAL's" individual components are displayed in this figure.

Table (2) [A]. The total scores of Neonatal F (Source: Author)

Agreement	**Neonatal F**
IRO Agreement	
Crohnbrach's α	0.97
p-value	<0.001
96% confidence interval	0.96–0.98
IRAO agreement	
p-value	<0.001
ICCO 2-3	0.90
ICCO 1–5	0.93
ICCO 4–6	0.90
Crohnbach'sα	0.95

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96% confidence interval	0.96–0.98

Table (2) [B]. The total scores of Mature F (Source: Author)

Agreement	Mature F
IRO agreement	
Crohnbach's α	0.95
96% confidence interval	0.93–0.96
p-value	<0.001
IRAO agreement	
ICCO 1–5	0.6
ICCO 2–3	0.88
ICCO 4–6	0.6
Crohnbach'sα	0.7
96% confidence interval	0.78–0.92
p-value	<0.001

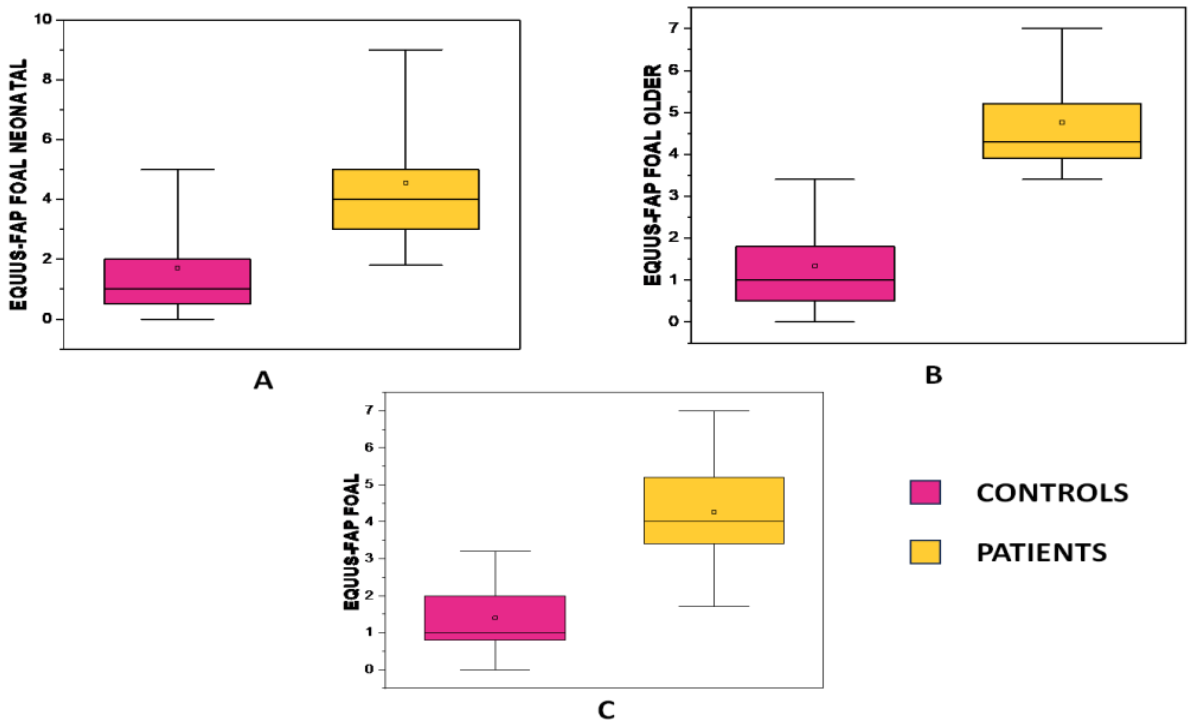

Figure (1). Sufferer compared to controls using the "EQUUS-FAP F"; **[A]:**"EQUUS-FAP FOAL" in newborn F; **[B]** :"EQUUS-FAP FOAL" in matured F ;**[C] :** All F. (Source: Author)

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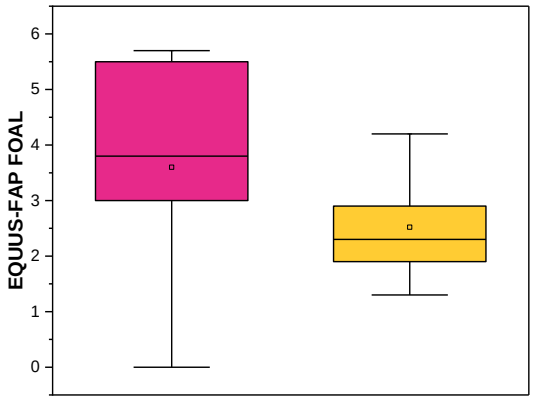

Figure (2). "EQUUS-FAP FOAL", was administered to sufferer either immediately before or 1-3 hours after receiving NSAID treatment (Source: Author)

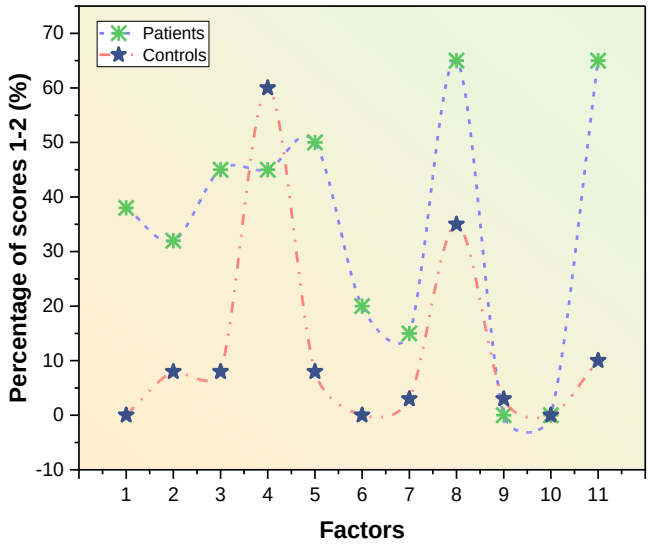

Figure (3). "EQUUS-FAP FOAL"frequency distribution and the unit of facial motion (Source: Author)

Figure (4). Examples of a Warmblood colt newborn, nine day's old following surgery for a fractured medial phalanx. (Source: https://www.mdpi.com/animals/animals-12-00439/article_deploy/html/images/animals-12-00439-g001.png)

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CONCLUSION

This research explains that here is a possibility of finding F pain through facial expressions. It can be feasible to diagnose acute pain in foals using a pain hierarchy depend on face gestures. There was good to outstanding agreement across observers and it was easy to distinguish between healthy, both foals with an acute pain and those without it. Before this pain scale is utilized on clinical sufferer, more research is required to confirm its validity. The "EQUUS-FAP FOAL" scale was used to the sixty-nine foals in the study, 30 sufferers with acute medical conditions and 39 healthy controls. The videos of the foals, which lasted 40 to 70 seconds, were assessed by three evaluators who were blindfolded to them. The goal of the current study was to enable meaningful evaluation of discomfort in foals by modifying the face expression-based "EQUUS-FAP FOAL", which was developed for senior horses. The study's findings corroborate the efficacy of the "EQUUS-FAP FOAL" discomfort hierarchy, which depends on face gestures and it is used to measure acute pain in foals.

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