Objective pain recognition and quantification in horses before and after orthopaedic surgery using pain scoring systems

Facial Assessment of Pain &

Composite Pain Scale

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1 Abstract

Objective recognition and quantification of pain in horses have been studied extensively in the past several decades, but there is still a desire for improvements. This study described the objective recognition and quantification of pain in horses before and after orthopaedic surgery measured with two different pain scales, the Facial Assessment of Pain (FAP) and the Composite Pain Scale (CPS). Ten patients with orthopaedic injuries that needed surgery and ten healthy pain free control horses were used (n = 20). Patients were scored before surgery, short after surgery (4 hours) and three days post-surgery in the morning, before the administration of pain medication, and in the afternoon, after the administration of pain medication. The horses were scored by two observers to determine the inter-observer reliability of the two pain scales. The observers scored the horses simultaneously, but didn't discuss their findings. FAP scores were assessed with live and video observations and CPS scores were assessed with only live observations. Both the FAP and the CPS scored an acceptable inter-observer reliability for live observations ($r = 0.74$, $P < 0.001$ for the FAP and $r = 0.91$, $P < 0.001$ for the CPS), while a weak FAP inter-observer reliability was found with video observations ($r = 0.08$, $P = 0.63$) or between the FAP live and video observations ($r = -0.09$, $P = 0.60$). Both pain scales were able to distinguish between control horses and patients, but only the FAP was able to differentiate between patients before and after the administration of pain medication and between patients before and after the surgery. The FAP is therefore more reproducible for the objective recognition and quantification of pain in horses before and after orthopaedic surgery than the CPS. However, more patients and therefore more studies are needed to make the outcome of this study more reliable.

2 Introduction

2.1 Pain recognition and quantification in horses

Objective pain recognition in horses has received plentiful attention over the past several decades (Lerche, 2009; Wagner, 2010). Pain evaluation helps with clinical-decision making (Ashley et al., 2005) and reducing pain to a minimum has become an important goal (Bisgaard et al., 2001; Sellon et al., 2004). Inflammation in the horse could cause sensitization, which eventually results in hyperalgesia, an enhanced perception of painful stimuli. Pain management is therefore necessary to decrease the change of sensitization and hyperalgesia (Schaible et al., 2009). However, pain recognition in horses has been found to be challenging, especially with early pain or with subtle signs of pain. Moreover, it is commonly known that horses possibly suppress their pain behaviour in a stressful or threatening situation (Taylor et al., 2002). For a long time, pain was only evaluated with heart rate and respiratory rate because they were considered affected by pain and easily measured, but these parameters are also influenced by other factors, such as stress, anxiety and excitement, and therefore non-specific for the presence and severity of pain (Dujardin and van Loon, 2011). The Visual Analogue Scale (VAS) is also an old-fashioned pain scoring system that was originally used for humans. A human patient needs to mark its pain on a horizontal 10 cm line, which represents the amount of pain with on the left side no pain and on the right side worst pain imagined (de Grauw and van Loon, 2016). This system is easy to use; however, for veterinary use it is very subjective, because not the patient itself but an observer defines the pain and the VAS doesn't have specific parameters to observe. Besides, the inter-observer reliability is suboptimal and the score is influenced by the amount of time taken to observe the horse (Lindegaard et al., 2010).

2.2 Pain scoring systems

Nowadays there is a variety of pain scoring systems that are commonly used. For example, numerical rating scales, which are discontinuous, ordinally scaled and have an accepted range of repeatability. Visual analogue scales are continuous, sensitive, but have a low repeatability and inter-observer reliability (Lindegaard et al., 2010). Simple descriptive scales are nonlinear and have a subjective interpretation of descriptors. Lastly, composite multifactorial scales are complex, have multidimensional elements, are considered long and difficult to interpret (Ashley et al., 2005). The Composite Pain Scale (CPS), for example, that Bussière et al., (2008) describe is divided into different parameters that can be ranked from 0 to 3, but every number (0, 1, 2 and 3) within these parameters have their own description. This makes the ranking of the parameters objective, because the observer can simply choose the number with the description that describes the behaviour of the horse best. Therefore, knowledge about the different parameters that are used in the pain scale is important.

Although it would be convenient to find one pain scoring systems that could be used for any type of pain in horses, it is difficult, since pain behaviour is not only specific for one type of species, but can also be specific to the origin of pain. This would suggest that it is impossible to create a general pain scoring system, but several improvements were made so far. For example, Bussières et al. (2008) describe the success of measuring the amount of pain in horses with acute orthopaedic injuries evaluated by the Composite Pain Scale (CPS), but the same pain scoring system was used successfully by van Loon et al. (2014) in horses with postsurgical gastrointestinal pain. This is possible because, even though this pain scale was made for the recognition of orthopaedic pain, the CPS contains parameters that can be applied to both orthopaedic and visceral pain (van Loon et al., 2014). Other composite pain scales are the Post Abdominal Surgery Pain Assessment Scale (PASPAS) (Graubner et al., 2011), the Composite Measure Pain Scale (CMPS) (Lindegaard et al., 2010) and the Equine Utrecht University Scale for Composite Pain Assessment (EQUUS-COMPASS) (van Loon and van Dierendonck, 2015).

2.3 Equine Pain Face

Another means of pain expression that could be possible to assess the general amount of pain in horses is the facial expression (Gleerup et al., 2015). It is widely accepted that humans possess the skill to recognise emotions through facial expression in other humans and animals (Deyo et al., 2004; Kadosh and Johnson, 2007). Facial expressions change when experiencing pain, which make them usable to evaluate pain (Gleerup et al., 2015). Besides that, even if it is desired to hide the pain, facial expressions are considered to show signs of pain one way or another (Prkachin and Mercer, 1989). Only recently the facial expression has been used for the assessment of pain in animals (Flecknell, 2010). The Equine Pain Face has been described in a study in which they observed the equine pain face after exposing the horses to induced pain (Gleerup et al., 2015). For horses, two pain scales are known, which are the Horse Grimace Scale (HGS) (Dalla Costa et al, 2014) and the Facial Assessment of Pain (FAP) (van Loon and van Dierendonck, 2015). The Facial Assessment of Pain (FAP) has been described in three studies so far. Van Loon and van Dierendonck (2015), described the assessment of pain in colic patients at arrival and two following mornings after arrival. The FAP showed high inter-observer reliability and the internal sensitivity and specificity were also good. Moreover, the FAP was successful in repeatable and objective scoring of pain in horses with acute colic. A follow-up study has been described by van Dierendonck and van Loon (2016) in which the validity of the FAP has been successfully assessed. Finally, the FAP has been successfully used for the facial assessment of pain in horses with acute or postoperative pain originating from the head, including dental pain, ocular pain and trauma to the skull (van Loon and van Dierendonck, 2017). The Horse Grimace Scale (HGS) is similar to the FAP and has been described in horses undergoing surgical castration (Dalla Costa et al., 2014) and in horses with acute Laminitis (Dalla Costa et al., 2016). The HGS scores the horses on 6 parameters and the FAP on 9. Besides, the HGS asks if a certain behaviour pattern is present, for example, are the ears stiffly backwards and the FAP asks what the ears do and gives 3 options.

2.4 Aim of this study

In this study, two different existing pain scoring systems, the Composite Pain Scale (CPS) and the Facial Assessment of Pain (FAP), were used to measure pain in horses before and after orthopaedic surgery. The objective is to determine whether the CPS and FAP are reliable instruments for objective pain scoring in horses undergoing orthopaedic surgery. Therefore, the horses were scored before and after surgery and before and after administration of pain medication. Besides, the horses were filmed to evaluate pain with the FAP in the patients by video a month after live observations.

The hypotheses are: *'The FAP- and the CPS-pain scores are both reliable for the evaluation of pain in horses undergoing orthopaedic surgery, they both have a high inter-observer reliability for live observations and a high inter-observer reliability for the FAP video observations and are able to distinguish between before and after the administration of pain medication and between pre- and postoperative conditions concerning different types of orthopaedic injuries.'*

3 Materials and Methods

3.1 Horses

This study has been approved by the Institution for animal welfare of Utrecht University. For the approval of the participation of the horses the owners signed a consent form (**Attachment 1**).

Ten horses were admitted to the university clinic for orthopaedic surgery were assessed and ten healthy pain free control horses from the university were used for this research (**Table 1**). The total study population consisted of 14 mares and 6 geldings. Breeds included Royal Warmblood Horse Netherlands (KWPN) (14), Friesians (2), Hanoverian (1), Royal Warmblood Horse Germany (KWPD) (1), Trakehner (1) and unknown (1). Type of injury or surgery that were included in the ten patients were mild and not considered acute (**Table 2**). Analgesic treatment and clinical-decision making were the responsibility of the attending veterinarian, the observers were not involved with day-to-day patient care, but they were aware of the administration of analgesic treatment of the patients. For the analgesic treatment after surgery Meloxicam (Metacam 20 mg/ml) was used, but patient number 2 was treated with tramadol (Ultram).

Table 1
Data of horses in this study (n = 20).

	Patient	**Control**
Number of horses	10	10
Mare	5	9
Gelding	5	1
KWPN	7	7
Other breeds	3	3
Mean (±SD) age (years)	8,7 (4,6)	10,3 (3,8)
Mean (±SD) weight (kg)	557,8 (65,5)	575,1 (54,8)
General anaesthesia	9	-
Local/regional sedation	1	-

Table 2
Type of injury or surgery included in this study. (LF) left front, (RF) right front, (LH) left hind, (RH) right hind.

Patient	**Type of injury/surgery**	**Bandage**
1	Metatarsal (splint bone) fracture (LH)	Yes
2	Subchondral bone cyst lateral femur condyle (RH)	No
3	Metatarsal (splint bone) fracture (RH)	Yes
4	Arthroscopy proximal interphalangeal joint (pastern joint) (LH)	Yes
5	Fetlock wound (LF)	Yes
6	Periostitis, tibia sequester (RH)	Yes
7	Arthroscopy metacarpophalangeal joint (fetlock joint) (LF)	Yes
8	Pododermatitis and fracture of distal phalanx (IV) (RH)	Yes
9	Arthroscopy stifle joint (knee joint) (LH)	No
10	Tenoscopy carpus (LF)	Yes

Nine out of ten participating patients had to undergo general anaesthesia for their orthopaedic surgery. Patient 5 only received local sedation and blocks. Premedication for general anaesthesia was provided with Detomidine (Domosedan 10 mg/ml) and Butorphanol Tartrate (Dolorex 10 mg/ml), but two of the nine horses that needed general anaesthesia received Morfine (10 mg/ml) instead of Dolorex. One horse received Acepromazine (Vetranquil 10 mg/ml). Induction of general anaesthesia was performed with Diazepam (5 mg/ml) and Ketamine (Narketan 100 mg/ml) through a catheter. As maintenance, most of the horses received Detomidine CRI (Domosedan 10 mg/ml) and inhalation anaesthesia with Isoflurane (per minute). Some horses received NaCl 0.9%. Instead of Detomidine CRI (Domosedan 10 mg/ml) ketamine (Narketan 100 mg/ml) was also performed in some cases. Ringers solution was used for fluid therapy and dobutamine was administered in case of low blood pressures. Bupivacaine (Chirocaine 2.5 mg/ml) was used for local anaesthetic blocks. Lastly, most horses were also treated with Meloxicam (Metacam 20 mg/ml) both in premedication and after surgery for post-operative analgesia, but some patients received Ketoprofen (Cronyxin 50 mg/ml). A full schedule can been found in **Attachment 2**.

3.2 Facial Assessment of Pain (FAP)

The FAP or Facial Assessment of Pain includes 9 parameters that describe different elements of the facial expression (**Table 3**). Every parameter needs to be observed and scored between 0 and 2. This means that the total pain score that contains all different elements can vary between 0 and 18 in which 0 means no signs of pain and 18 means maximal pain score (van Loon and van Dierendonck, 2015).

Table 3
Facial Assessment of Pain (FAP) (van Loon and van Dierendonck, 2015).

Score sheet of the Equine Utrecht University Scale for Facial Assessment of Pain (EQUUS-FAP).[2]

Head	Normal head movement/interested in environment	0
	Less movement	1
	No movement	2
Eyelids	Opened, sclera can be seen in case of eye/head movement	0
	More opened eyes or tightening of eyelids. An edge of the sclera can be seen 50% of the time	1
	Obviously more opened eyes or obvious tightening of eyelids. Sclera can be seen >50% of the time	2
Focus	Focussed on environment	0
	Less focussed on environment	1
	Not focussed on environment	2
Nostrils	Relaxed	0
	A bit more opened	1
	Obviously more opened, nostril flaring and possibly audible breathing	2
Corners mouth/lips	Relaxed	0
	Lifted slightly	1
	Obviously lifted	2
Muscle tone head	No fasciculations	0
	Mild fasciculations	1
	Obvious fasciculations	2
Flehming and/or yawning	Not seen	0
	Seen	2
Teeth grinding and/or moaning	Not heard	0
	Heard	2
Ears	Position: Orientation towards sound/clear response with both ears or ear closest to source	0
	Delayed/reduced response to sounds	1
	Position: backwards/no response to sounds	2
Total		***.../18***

3.3 Composite Pain Scale (CPS)

The CPS or Composite Pain Scale is a composed numerical rating scale designed by Bussières and his group (**Table 4**). It contains physiological parameters, behavioural elements and interaction parameters which were believed to identify orthopaedic pain best (Bussières et al., 2008). 18 healthy horses were used in this study. They were divided into six groups, each containing 3 horses. Three control groups, without pain induction, and three experimental groups in which synovitis pain was induced. These 3 groups received different analgesic treatment to obtain different levels of pain. This study found a good inter- and intra-observer reliability ($0.8 < K < 1$). Moreover, a statistical correlation was observed between the CPS and both blood pressure ($P < 0.0001$) and blood cortisol ($P < 0.002$). The behavioural and physiological parameters for the assessment of orthopaedic pain in horses were successful.

The parameters of this pain scale can be scored between 0 and 3. The total pain score that contains all different elements could be situated between 0 and 39 in which 0 means no signs of pain and 39 means maximal pain score (Bussières et al., 2008).

To use this pain scale in this study one parameter has been changed. Bussières et al (2008) divide the parameter ‘Appearance’ in four different degrees in which degree 0 means ‘bright, lowered head and ears, no reluctance to move’ and degree 1 means ‘bright and alert, occasional head movements, no reluctance to move’. For this study, the description of degree 0 and 1 have been switched, which means in our study degree 0 has the description ‘bright and alert, occasional head movements, no reluctance to move’ and degree 1 has the description ‘bright, lowered head and ears, no reluctance to move’.

Table 4
Composite Pain Scale (CPS) (Bussières et al., 2008).

Multifactorial numerical rating composite pain scale (CPS)

Score sheet of the multifactorial numerical rating composite pain scale (CPS)

Behaviour		
Kicking at abdomen	Quietly standing, no kicking	0
	Occasional kicking at abdomen (1-2 times/5 min)	1
	Frequent kicking at abdomen (3-4 times/5 min)	2
	Excessive kicking at abdomen (>5 times/5 min), intermittent attempts to lie down and roll	3
Pawing on the floor (pointing, hanging limbs)	Quietly standing, no pawing	0
	Occasional pawing (1-2 times/5 min)	1
	Frequent pawing (3-4 times/5 min)	2
	Excessive pawing (>5 times/ 5 min)	3
Head movement	No evidence of discomfort, head straight ahead for the most part	0
	Intermittent head movements laterally or vertically, occasional looking at flanks (1-2 times/5 min),	1
	lip curling (1-2 times/ 5 min)	1
	Intermittent and rapid head movements laterally or vertically, frequent looking at flank (3-4 times/5 min),	2
	lip curling (3-4 times/5 min)	2
	Continuous head movements, excessively looking at flank (>5 times/5 min), lip curling (>5 times/5 min)	3
Appearance	Bright and alert, occasional head movements, no reluctance to move	0
	Bright, lowered head and ears, no reluctance to move	1
	Restlessness, pricked up ears, abnormal facial expressions, dilated pupils	2
	Excited, continuous body movements, abnormal facial expression	3
Posture (weight distribution, comfort)	Stands quietly, normal walk	0
	Occasional weight shift, slight muscle tremors	1
	Non-weight bearing, abnormal weight distribution	2
	Analgesic posture (attempts to urinate), prostration, muscle tremors)	3
Appetite	Eats hay readily	0
	Hesitates to eat hay	1
	Shows little interest in hay, eats very little or takes hay in mouth but does not chew or swallow	2
	Neither shows interest in nor eats hay	3
Sweating	No obvious signs of sweat	0
	Damp to the touch	1
	Wet to the touch, beads of sweat are apparent over the horse's body	2
	Excessive sweating, beads of water running off the animal	3
Response to treatment		
Interactive behavior	Pays attention to people	0
	Exaggerated response to auditory stimulus	1
	Excessive-to-aggressive response to auditory stimulus	2
	Stupor, prostration, no response to auditory stimulus	3
Response to palpation of painful area	No reaction to palpation	0
	Mild reaction to palpation	1
	Resistance to palpation	2
	Violent reaction to palpation	3

Response to treatment		
Interactive behavior	Pays attention to people	0
	Exaggerated response to auditory stimulus	1
	Excessive-to-aggressive response to auditory stimulus	2
	Stupor, prostration, no response to auditory stimulus	3
Response to palpation of painful area	No reaction to palpation	0
	Mild reaction to palpation	1
	Resistance to palpation	2
	Violent reaction to palpation	3

Physiologic data		
Respiratory rate	Normal compared to intitial value (increase <10%)	0
	11-30% increase	1
	31-50% increase	2
	>50% increase	3
Heart rate	Normal compared to intitial value (increase <10%)	0
	11-30% increase	1
	31-50% increase	2
	>50% increase	3
Rectal temperature	Normal compared to intitial value (variation < 0,5°C)	0
	Variation les 1°C	1
	Variation les 1,5°C	2
	Variation les 2°C	3
Digestive sounds	Normal motility	0
	Decreased motility	1
	No motility	2
	Hypermotility	3
Total		.../39

3.4 Study design

Two veterinary students performed the observations for the pain scores. They scored the horses simultaneously, but didn't discuss their findings. The observers were aware of the clinical diagnosis and clinical treatment of the patients participating in this study. Patients were observed for five days during their stay at the clinic for orthopaedic surgery, which includes observations presurgery (1 or 2 times a day), short (4 hours) after surgery (1 time) and three following days post-surgery (3 or 5 times a day) (**Table 5)**. The observation period was 15 minutes, which included the pain scoring with Facial Assessment of Pain (FAP) and Composite Pain Scale (CPS) and one minute of filming the patient. An extra observation period was added for some horses that could walk for five minutes outside the box guided on a halter and rope. These horses were scored with the FAP and CPS again after they returned to their box from the walk. Besides, these horses were filmed for FAP video scoring after they returned to their box as well. The table that has been used to write down the scores of the pain scales per patient can been found in **Attachment 3**. The patients only stayed at the clinic for the time period they needed to stay to recover from surgery, which means that not all the horses participated the entire study schedule. Besides, not every horse could leave its box, which excluded some horses from parts of the study. The pain scores of the observations after walking were not analysed in this study due to the small amount of data that was collected. However, the collected data were used for a coherent study that compared the pain scores to the Qhorse scores of the same patients.

The FAP pain scale was used for pain scoring with live and video observations in this study on patients that came in for orthopaedic surgery. The control horses were only scored with the live observations once and were not filmed. Live observations mean the horse moving freely in the box while the observers stood outside the box scoring the horse with the FAP and CPS pain score. Video recording was taken from inside the box while the horse was wearing a halter and was kept on a rope to avoid it from moving. The video recordings only include the head and parts of the neck, the rest of the body or environment is not visible on the video. The observers scored the video recordings a month after the live observations and the observers were blinded for time and patients while observing the video recordings. However, patients were recognised on the video recordings by the observers.

The CPS pain scale was only used for the live observations for both the patients before and after orthopaedic surgery and the control horses. The control horses were only scored once with live observations and were not filmed. The interaction parameters and behavioural elements have been scored from outside the box while the horse could move freely inside the box. The physiological parameters have been scored from inside the box while the horse was wearing a halter and was kept on a rope to avoid it from moving. A stethoscope, stopwatch and a thermometer were used to collect the scores for the physiological parameters.

Table 5
Study schedule.

Day -1: Pre-surgery	
• Measuring pain scores FAP and CPS	No specific time
• Walk horse for 5 minutes	No specific time
• Measuring pain scores FAP and CPS	No specific time
Day 0: Surgery	
• Measuring pain scores FAP and CPS	4 hours after surgery
Day 1: Post-surgery	
• Measuring pain scores FAP and CPS	7AM (Before pain medication)
• Walk horse for 5 minutes	7.15AM (Before pain medication)
• Measuring pain scores FAP and CPS	7.20AM (Before pain medication)
• Measuring pain scores FAP and CPS	10AM (After pain medication)
• Walk horse for 5 minutes	10.15AM (After pain medication)
• Measuring pain scores FAP and CPS	10.20AM (After pain medication)
• Measuring pain scores FAP and CPS	2PM (After pain medication)
Day 2: Post-surgery	
• Measuring pain scores FAP and CPS	7AM (Before pain medication)
• Walk horse for 5 minutes	7.15AM (Before pain medication)
• Measuring pain scores FAP and CPS	7.20AM (Before pain medication)
• Measuring pain scores FAP and CPS	10AM (After pain medication)
• Walk horse for 5 minutes	10.15AM (After pain medication)
• Measuring pain scores FAP and CPS	10.20AM (After pain medication)
• Measuring pain scores FAP and CPS	2PM (After pain medication)
Day 3: Post-surgery	
• Measuring pain scores FAP and CPS	7AM (Before pain medication)
• Walk horse for 5 minutes	7.15AM (Before pain medication)
• Measuring pain scores FAP and CPS	7.20AM (Before pain medication)
• Measuring pain scores FAP and CPS	10AM (After pain medication)
• Walk horse for 5 minutes	10.15AM (After pain medication)
• Measuring pain scores FAP and CPS	10.20AM (After pain medication)
• Measuring pain scores FAP and CPS	2PM (After pain medication)

3.5 Data processing and statistical analysis

IBM SPSS Statistics 24 was used for the statistical analysis in this study. Every statistical test used in this study has been analysed by this program. Statistical significance was accepted at $P < 0,05$.

Inter-observer reliability was assessed using Spearman's correlation coefficients (r). Inter-observer reliability was examined on the Facial Assessment of Pain (FAP) and Composite Pain Scale (CPS) live observations between the two participating observers scoring the horses in this study. Inter-observer reliability was examined on the FAP video observations between the two participating observers and between the live and video observations from the FAP pain score. For the inter-observer reliability between the live and video observations the average of the scores from the two participating observers has been used.

The Friedman Test has been used to analyse the effects over time on the patients scored by the FAP and the CPS. The average of the scores from the two participating observers has been used and the FAP and the CPS have been analysed separately. For the time effect, different scoring moments from the study schedule were included, which were before surgery, four hours after surgery, first day after surgery before and 5 hours after pain medication and the same for the second and third day postsurgery.

The Mann Whitney U Test was used to analyse the differences in FAP and CPS scores between groups of horses. The FAP and the CPS were analysed separately and for both pain scores the average of the scores from the two participating observers has been used. This statistical test analysed the differences in pain score for the FAP and the CPS between the healthy pain free control group of horses and the patients before the orthopaedic surgery, the differences in pain score for the FAP and CPS between the healthy pain free control group of horses and the patients four hours after surgery, the differences in pain score for the FAP and CPS between the patients before pain medication and patients five hours after pain medication and lastly the differences in pain score for the FAP and CPS between patients before the surgery and patients four hours after surgery.

4 Results

4.1 Inter-observer reliability for live observations

Fig. 1 shows the results of correlation analysis of the Facial Assessment of Pain (FAP) live observations between two different observers (r = 0.74, ***P < 0.001). Fig. 2 shows the results of correlation analysis of the Composite Pain Scale (CPS) live observations between the same two different observers (r = 0.91, ***P < 0.001). The CPS showed a strong and significant correlation and the FAP showed a good and significant correlation

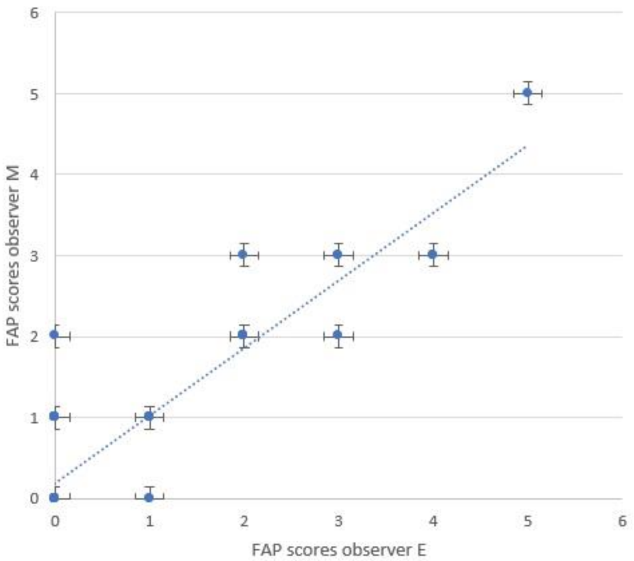


Fig 1. Scatter plot of Facial Assessment of Pain (FAP) live observations, assessed by observer E (x-axis) and observer M (Y-axis) at the same time (n = 62 double observations in 6 patients and 10 control horses, some dots contain multiple observation scores), r = 0,74 (***P < 0,001).

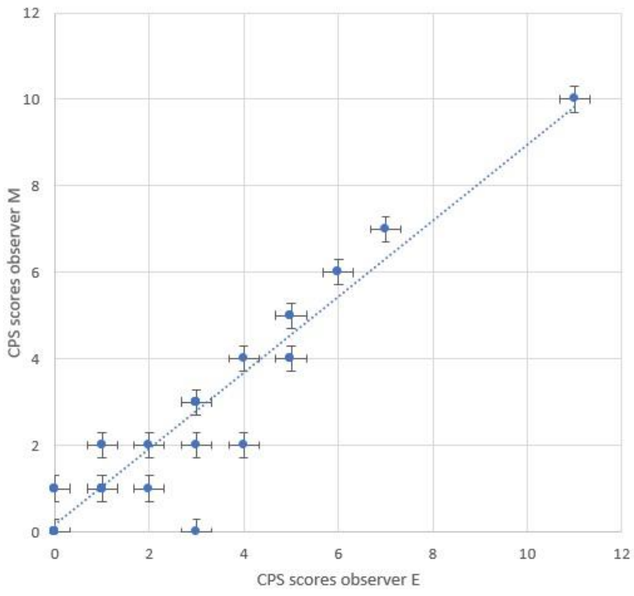


Fig 2. Scatter plot of Composite Pain Scale (CPS) live observations, assessed by observer E (x-axis) and observer M (y-axis) at the same time (n = 62 double observations in 6 patients and 10 control horses, some dots contain multiple observation scores), r = 0,91 (***P < 0,001).

4.2 Inter-observer reliability for video observations

Fig. 3 shows the results of correlation analysis of the Facial Assessment of Pain (FAP) video observations between two different observers (r = 0.08, P = 0.63). Fig. 4 shows the results of correlation analysis of the FAP between the live observations and video observations (r = -0.09, P = 0.60). The FAP showed a very weak and non-significant correlation with video observations between two different observers. The FAP also showed a very weak and non-significant correlation between the live observations and the video observations.

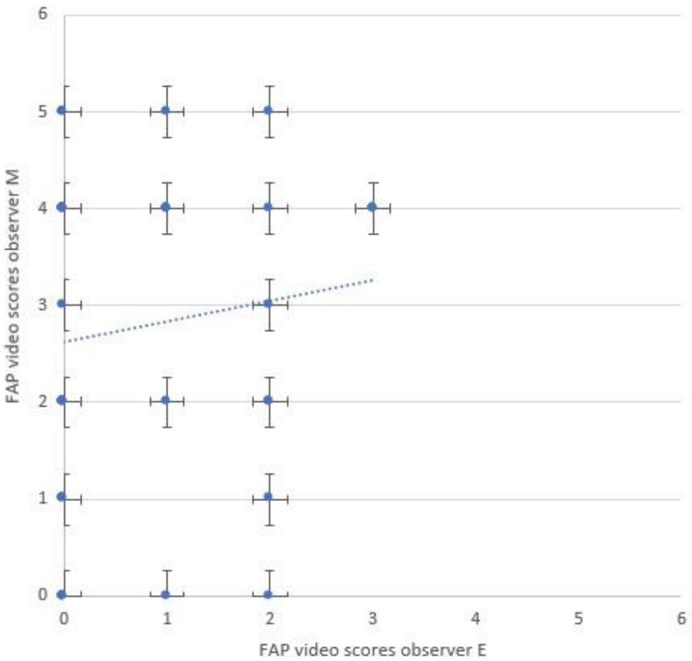


Fig 3. Scatter plot of Facial Assessment of Pain (FAP) video observations, assessed by observer E (x-axis) and observer M (y-axis) at the same time (n = 38 double observations in 5 patients, some dots contain multiple observation scores), r = 0,08 (P = 0,63).

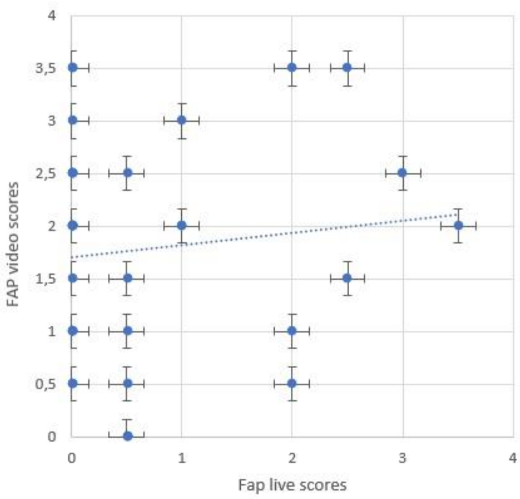


Fig 4. Scatterplot of Facial Assessment of Pain (FAP) mean values of observer E (x-axis) and observer M (y-axis) from live and video observations (n = 38 double observations in 5 patients, some dots contain multiple observation scores), r = -0,09 (P = 0,60).

4.3 *Effect over time on the pain score*

Fig. 5 shows that no effect over time was found for the FAP scores (P = 0.17, Chi-square = 10.37, df = 7) and Fig. 6 shows that no effect over time was found for the CPS scores (P = 0.72, Chi-square = 4.53, df = 7).

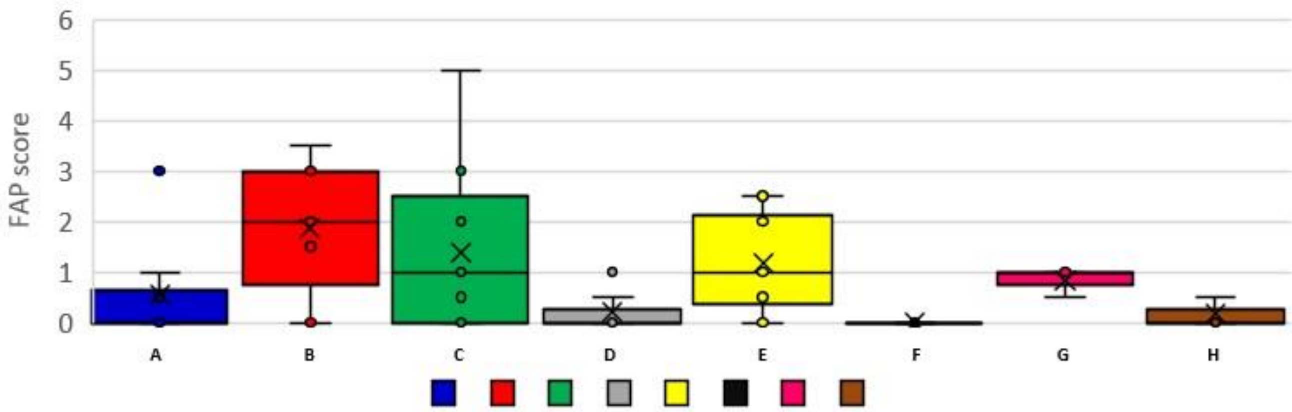


Fig 5. Facial Assessment of Pain (FAP) scores on different moments. (A) before surgery (n = 8), (B) four hours after surgery (n = 7), (C) first day after surgery, before pain medication (n = 9), (D) first day after surgery, five hours after pain medication (n = 7), (E) second day after surgery, before pain medication (n = 8), (F) second day after surgery, five hours after pain medication (n = 4), (G) third day after surgery, before pain medication (n = 3), (H) third day after surgery, five hours after pain medication (n = 3). P = 0,17, Chi-square = 10,37, df = 7. Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

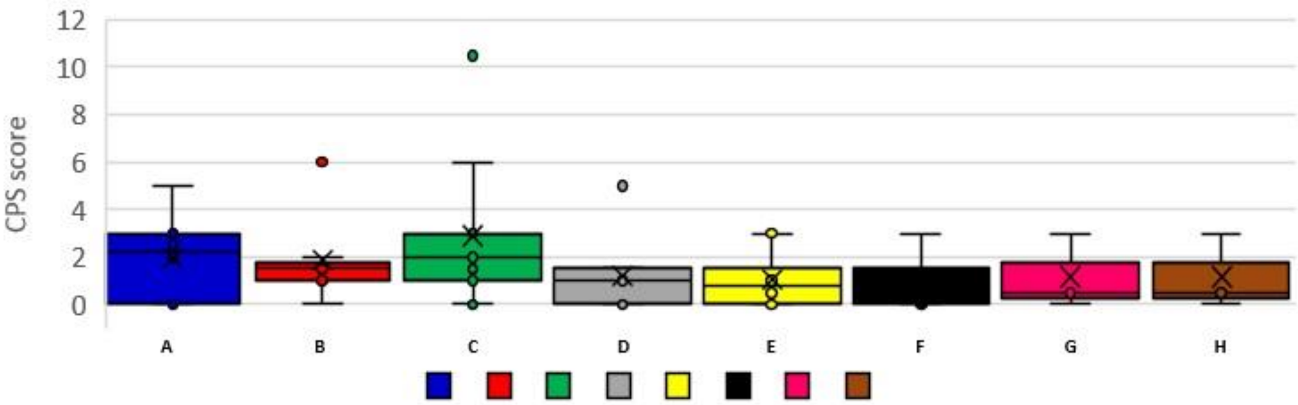


Fig 6. Composite Pain Scale (CPS) scores on different moments. (A) before surgery (n = 8), (B) four hours after surgery (n = 7), (C) first day after surgery, before pain medication (n = 9), (D) first day after surgery, five hours after pain medication (n = 7), (E) second day after surgery, before pain medication (n = 8), (F) second day after surgery, five hours after pain medication (n = 4), (G) third day after surgery, before pain medication (n = 3), (H) third day after surgery, five hours after pain medication (n = 3). P = 0,72, Chi-square = 4,53, df = 7. Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

4.4 Pain scores before and after the administration of pain medication

Fig. 7 shows the FAP scores before and 5 hours after the administration of pain medication for day 1 and day 2 after surgery. A significant decrease in FAP score was found after the administration of pain medication (P = 0.005). Fig. 8 shows the CPS scores before and 5 hours after the administration of pain medication for day 1 and day 2 after surgery. A significant decrease between the patients before pain medication and the patients five hours after pain medication wasn't found (P = 0.32).

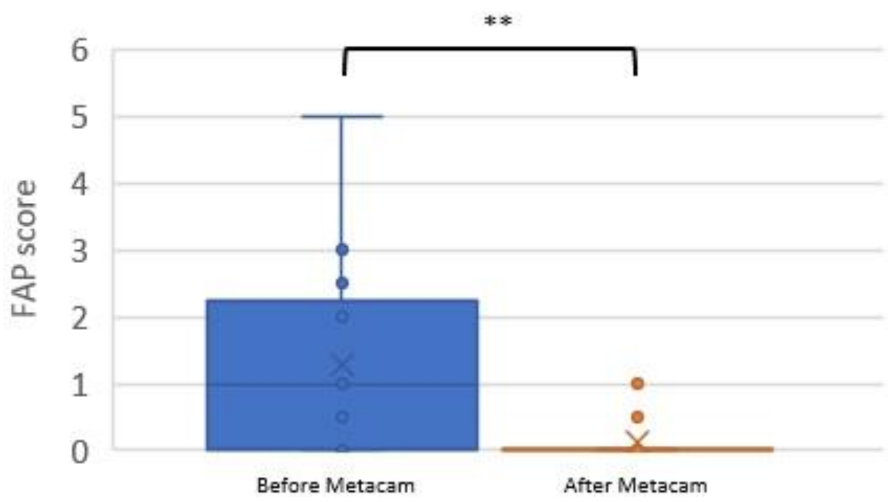


Fig 7. Facial Assessment of Pain (FAP) scores from n = 17 patients on day 1 and 2 for before Metacam and n = 11 patients on day 1 and 2 five hours after Metacam were included (**P = 0,005). Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

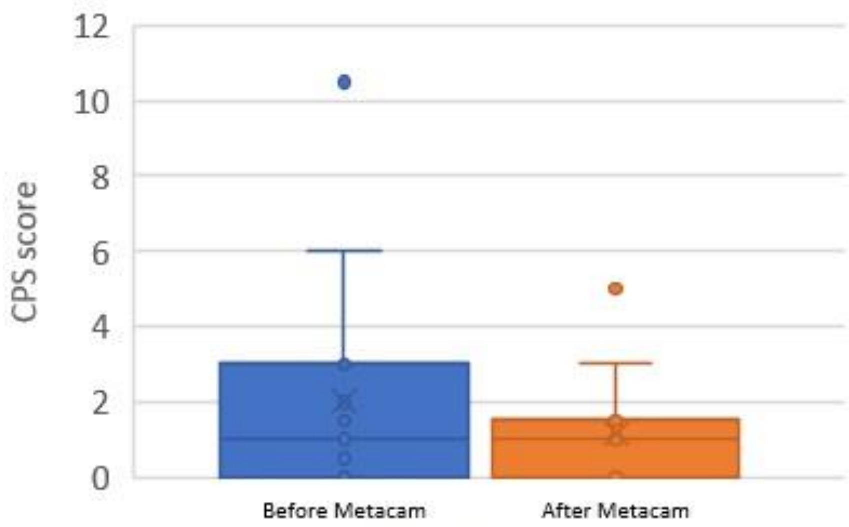


Fig 8. Composite Pain Scale (CPS) scores from n = 17 patients on day 1 and 2 before Metacam and n = 11 patients on day 1 and 2 five hours after Metacam were included (P = 0,32). Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

4.5 Pain scores in patients versus control group

Fig. 9 shows the FAP scores for three groups and Fig. 10 shows the CPS scores for the same three groups, which are the healthy pain free control group, patients before surgery and patients four hours after surgery.

Significant differences were found between the FAP scores of the control horses and the patients four hours after surgery (*P = 0.019). Besides, a trend to significance was found between the FAP scores of patients before surgery and patients four hours after surgery (P = 0.086). Pain scores between control horses and patients before surgery were not significantly different (P = 0.46).

Significant differences were found between the CPS scores of the control horses and the patients before surgery (*P = 0.026) and also between the control horses and the patients four hours after surgery (**P =0.004). However, pain scores between patients before surgery and the patients four hours after surgery were not significantly different (P = 0.73).

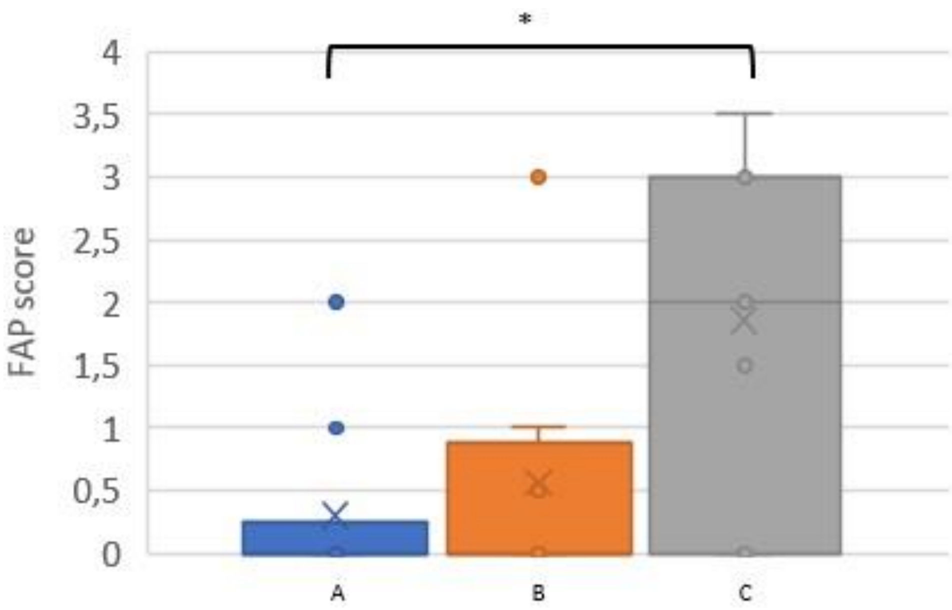


Fig 9. Facial Assessment of Pain (FAP) scores for the healthy pain free control group (A) (n = 10), patients before surgery (B) (n = 8) and patients 4 hours after surgery (C) (n = 7). Significant difference was found between A and C (*P = 0.019). A trend to significance was found between B and C (P = 0.086). No significant difference was found between A and B (P = 0.46). Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

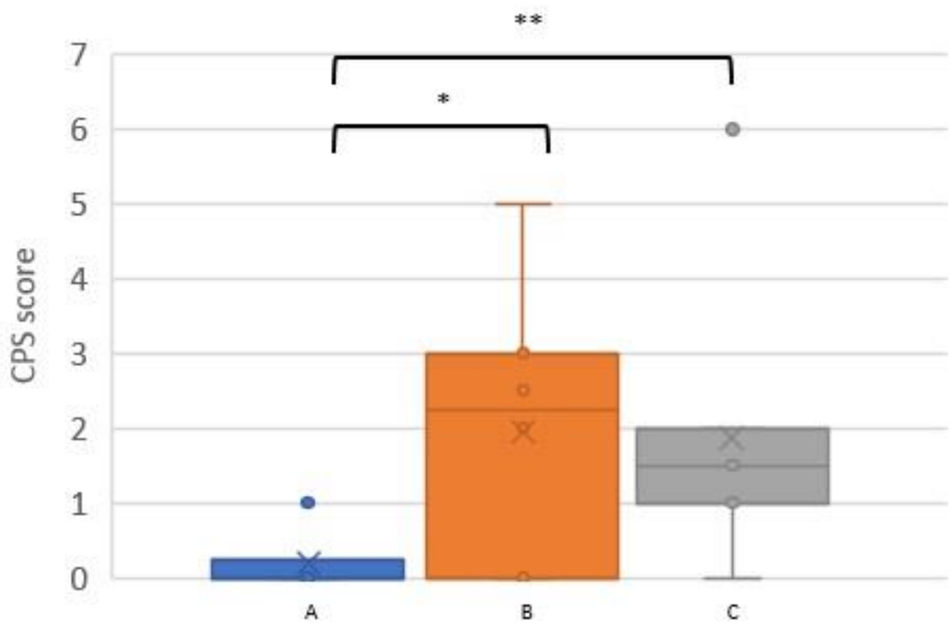
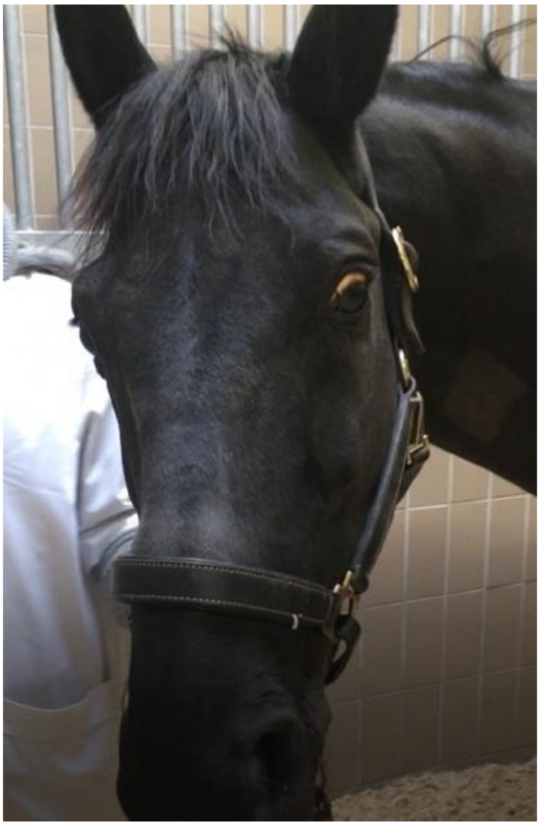


Fig 10. Composite Pain Scale (CPS) scores for the healthy pain free control group (A) (n = 10), patients before surgery (B) (n = 8) and patients 4 hours after surgery (C) (n = 7). Significant differences were found between A and B (*P = 0.026) and between A and C (**P = 0.004). No significance was found between B and C (P = 0.73). Lines in the bar show median scores; boxes show 25-75th percentiles; error bars show 5-95 percentiles; dots outside box and error bars show outliers.

4.6 Pictures of participating patients for FAP scores



Patient 2:
- Shows its sclera;
- Has its nostrils more opened;
- Corners of mouth/lips are slightly lifted.

Patient 4:
- Has less head movement;
- Is less focused on environment;
- Its ears are slightly backwards and have a reduced response to sounds.

Patient 3:
- Has less head movement;
- Is less focused on environment;
- Its ears are slightly backwards and have a reduced response to sounds.

Patient 6:
- Corners of mouth/lips are slightly lifted;
- Its ears are slightly backwards and have a reduced response to sounds.

5 Discussion

The inter-observer reliability for video observations with the FAP wasn't good, but for live observations with the FAP and CPS it was good for this study. Besides, a significant difference was found between the control horses and the patients after orthopaedic surgery for both pain scales. The CPS also showed a significance between the control horses and the patients before the surgery. However, only the FAP showed a significant difference between the patient before and after the administration of pain medication and showed a trend to significance between patients before and after the surgery.

5.1 FAP and CPS; valid pain scales?

Pain in horses needs to be assessed with behavioural and physiological observations. If these parameters are systematically observed the degree of pain could be assessed. The combination of these observations could make a quantitative pain scoring system (Gleerup and Lindegaard, 2016). Several elements were considered important for the construction of a pain scoring systems for horses. For example, Bussières et al (2008) claim that 'a pain evaluation scale has to give a clear result concerning the presence or absence of pain to ascertain the differentiation between horses with pain and healthy pain free control horses. Besides, a pain scale needs to be easy to use, but the observer must be able to record data as precisely as possible and because there is no verbal communication between the patient and the observer, the evaluation scale needs to include parameters that make sure different observers will observe the same pain score. Gleerup and Lindegaard (2016) however, write that usability is the most important factor of a pain scoring system. It is considered that an easy system fits better in a daily routine and could therefore be used in any given situation. Lastly, Ashley et al (2005) asserts that 'a pain scoring system is supposed to be linear and weighted, but more important sensitive to different types of pain, breed- and species-specific, observer-independent and closed to misinterpretation.'

This study concentrated on some of these elements that make a pain scale a valid test for the evaluation of pain in horses. The reliability of the pain scales is important for the objectivity of the test. This study also analysed whether the pain scales were able to ascertain the differentiation between horses with pain and pain free horses. The sensitivity for a specific type of pain was also tested. Ashley et al (2005) described that the CPS is a complex pain scale and hard to interpret. But both the observers of this study didn't find the CPS hard to interpret. They found it very easy to use. They also experienced that the FAP is more difficult to interpret than the CPS, because the FAP tries to pick up smaller signs of pain.

5.2 Inter-observer reliability for live observations

If a pain scale has a high inter-observer reliability it is considered observer independent. This is important to make sure a pain scoring system could be used by anyone who is interested in using it. In this study, the observers were both veterinary students and have been around horses nearly their whole life. If the pain scoring system is really observer independent any individual without any horse experience or veterinary background should be able to quantify the horses with the same pain scores as an experienced individual. Although it would be convenient to compose a pain scoring system that is usable for any individual, it is also important to make sure observers know how to use the pain scales and how to recognise signs of pain in horses. Training could therefore be necessary or mandatory before using the pain scales. For example, the Horse Grimace Scale (HGS) (Dalla Costa et al., 2014; Dalla Costa et al., 2016) has a training module for the smartphone that needs to be successfully completed before the Horse Grimace Scale App can be used.

In this study, the Composite Pain Scale (CPS) scored a higher inter-observer reliability than the Facial Assessment of Pain (FAP) with live observations (r = 0.91 for the CPS and r = 0,74 for the FAP), but they are both acceptable for this study. The CPS measures parameters that are easier to pick up while observing the horse, such as kicking at abdomen, appetite and sweating. The Facial Assessment of Pain however concentrates on subtle signs of pain, for example, the eyelids, nostrils, corners mouth/lips, which are therefore harder to measure. Besides, a part of the Composite Pain Scale is collecting physiological data of the horse, such as heart rate, temperature and respiration. Both observers should be able to measure the same scores if they are experienced with collecting these particular data and if they score the patient around the same time. This would make it easier for two different observers to measure the same pain score in the same patient at the same time.

In general, a good inter-observer reliability was found in the literature for both pain scales. Van Loon et al. (2014) found a high inter-observer reliability (r = 0.87) for the Composite Pain Scale scored in horses undergoing emergency gastrointestinal surgery and Lindegaard et al. (2010) found a good inter-observer reliability for the Composite Pain scale scored in horses with LPS-induced synovitis (Limits of agreement = −2.1; + 1.7, Agreement Index = 0.57). Van Loon et al., (2015) found a good inter-observer reliability for the EQUUS-COMPASS (r = 0.94) in horses with acute colic. This scale is similar to the CPS. This study also found a good inter-observer reliability for the EQUUS-FAP (r = 0.84), which is similar to the FAP. Van Loon and van Dierendonck (2017) found a high inter-observer reliability for the Facial Assessment of Pain in horses with head-related pain, including dental pain, ocular pain and trauma to the skull (ICC = 0.92). Dalla Costa et al. (2016) found a high overall inter-observer reliability for the Horse Grimace Scale (HGS), which is similar to the Facial Assessment of Pain, scored in horses with acute Laminitis (ICC = 0.85). This study also described the inter-observer reliability for the individual parameters of the HGS. ‘Ears’ was found to have the highest inter-observer reliability (ICC = 0.95) and ‘chewing muscles’ was found to have the lowest inter-observer reliability (ICC = 0.44). It would be interesting for this study to analyse the different parameters and describe the usability and inter-observer reliability of the different parameters for horses before and after orthopaedic surgery. Besides, more horses and horses with acute pain should be scored to analyse the inter-observer reliability even better.

5.3 Inter-observer reliability for video observations

Quantifying the amount of pain in horses by means of video recordings could be a solution for some situations. For example, if the horse needs to be scored in a hospital setting with unfamiliar people (veterinarian or nurse) walking in and out the box. An unfamiliar environment can affect the behaviour of the horse in relation to pain evaluation (Seibert et al., 2003). Consequently, the pain evaluation will be most effective when performed by familiar people to the horse or if the horse gets filmed and scored from the video recording. Gleerup et al. (2015) used a video camera to film the head and neck of horses undergoing induced pain with noxious stimuli. They analysed the video recordings for alterations in the horse’s behaviour and facial expressions. They found that it is possible to observe pain behaviour through a video recording in the facial expression. These horses were filmed with a camera in their box placed at a distance of two meters from the horse. The horses wore a neck collar which allowed them some head motions, sometimes even enough to move out of the frame of the camera. Dalla Costa et al. (2016) used video and pictures for pain evaluation with the Horse Grimace Scale (HGS) in horses with acute Laminitis. The inter-observer reliability was good for both the observations with the video recordings and the pictures scored with this HGS (ICC =0.95 for video and ICC = 0.85 for pictures).

In this study, the inter-observer reliability for video observations is very weak (r = 0.08) and the reliability between the live observations and the video observations of the FAP is also very weak (r = -0.09). Several factors could explain these low correlations. First, it is important to realise that the horses wore a halter and were kept on a rope during the video recordings. This could change the behaviour and pain face of these horses. The live FAP observations were scored from outside the box which could give the horse more space to show his pain or natural behaviour. Second, the video recordings were taken between five or ten minutes after the live observations. In this time, the pain face could have changed because of several factors, such as environment, feeding or stress. This could explain the difference in reliability between the live observations and video observations. Lastly, the quality of the video recordings was very bad. This was experienced by the two participating observers during this study. They found it difficult to determine the amount of pain by watching these videos. The hesitation for scoring the horses due to the bad quality of the video recordings could be an explanation for the weak inter-observer reliability for the video observations between the two observers, but also for the reliability between the live observations and the video observations. In a follow-up study, it would be convenient to change the film technique. For example, filming the horse from inside the box without a person next to the camera or the horse. This enables the horse to move around in its box and show its natural behaviour. Besides, this makes it easy for the observers to film the horse and score them in real live at the same time. It is important that the quality of the video recording doesn't influence the observers. It should be filmed in a way that makes the recording similar to the live observations.

5.4 Pain scores before and after pain medication from live observations

With scoring the patients before and after the administration of pain medication in the patients participating in this study the usability of the two pain scales, FAP and CPS, could be evaluated. It is important for the efficacy of the pain scales that they are able to register pain in horses and in this particular study in horses undergoing orthopaedic surgery. The significant decrease in pain scores after administration of NSAIDs suggests that the FAP pain score is actually measuring subtle postoperative orthopaedic pain, that responds to analgesic treatment. Since no significant decrease in pain scores was measured with the CPS after analgesic treatment suggests that the CPS is not able to detect subtle postoperative orthopaedic pain that was investigated in this study.

Reasons for the CPS to lack a significant result could be that the CPS was in this study unable to register the subtle postoperative orthopaedic pain. Besides, it could be that more patients need to be scored before a good significance shows up. In this study 17 patients were scores before Metacam and 11 horses were scored after Metacam.

5.5 Pain scores before and after orthopaedic surgery from live observations

The horses participating this study were considered to have a low amount of pain before they had to undergo orthopaedic surgery. The horses were scored before the surgery and these pain scores have been compared to the pain scores were measured between four and six hours after the surgery. This particular time was chosen to make sure the anaesthetics and sedative drugs from the surgery couldn't influence the behaviour of the horse anymore. The FAP shows nearly a significant difference in pain score between the patients before the surgery and the patients after the surgery, but the CPS is not close to a significant difference.

The FAP doesn't show a significance so far, but it is very close. A larger group of patients, and therefore more data, would possibly be enough to get the acceptable range of significance. Nevertheless, this outcome for the FAP is promising. The CPS on the other hand will need more than a few patients to reach the acceptable range of significance. This outcome means that the amount of pain measured in horses with this particular pain scale is very similar in the patients before the surgery and patients after the surgery. It could be possible that the difference is not high because the CPS is not able to pick up the subtle differences in pain signs in these horses undergoing orthopaedic surgery. Therefore, the pain score will be lower than it should have been and it will come close to the score of horses that are considered not to be in pain, in this case the patients before the surgery.

Dalla Costa et al. (2014) also described the effect of surgery on the horse concerning the amount of pain. They scored horses successfully with the Horse Grimace Scale (HGS) and the Composite Pain Scale (CPS) that had to undergo routine castration. The patients were divided into three groups. One group received a single perioperative injection of NSAID prior to anaesthesia immediately after administration of sedative drug. The second group received the same as group 1, but also received an oral application of NSAID. The third group is a control group and underwent the same general anaesthesia protocol as group 1 and 2 and received a single perioperative injection of NSAID to investigate the impact of general anaesthesia, but didn't undergo the surgery. The patients were also considered not to be in pain before surgery, but they were treated with analgesia after the surgery. The pain scores of group 1 and 2 for both the pain scales were significantly higher eight hours after surgery compared to presurgery. There was no significance between group 1 and 2, but there was a significant difference between group 1 and 2 and the control group. Dalla Costa et al. (2014) found that surgical castration effects the amount of pain in horses, despite the analgesia treatment the horses received. In this study, no significant difference was found. Although, the FAP came really close to a significance. Dalla Costa used 40 patients and this study only used 10. If more data was collected a significance could have showed up.

5.6 Pain scores of control group compared to patients undergoing orthopaedic surgery

With comparing a healthy pain free control group to a group of patients, using a pain scale to measure the amount of pain, the sensitivity and specificity could be tested. In this study, the healthy pain free control group has been compared to two groups, patients before orthopaedic surgery and patients four hours after orthopaedic surgery.

The FAP scores for the control group are not significantly different than the FAP scores in patients before the orthopaedic surgery, but the pain scores of the patients before surgery are higher than the pain scores of the control group. The patients that came in for surgery were not acute pain patients. This could be why this group is not so different from the healthy pain free control group. The healthy pain free control group does on the other hand significantly differ from the group of patients four hours after surgery. This was expected because the control group is considered to be free from pain and discomfort, which should give this group a low average pain score. However, the patients that are recovering from surgery are more likely to show some pain. They have wounds from surgery and have been on a surgery table for a while which is very uncomfortable and unnatural for a horse, which eventually resulted in higher pain scores for the patients after the surgery.

The CPS scores for the control group are significantly different than the CPS scores for both the patients before the surgery and the patients four hours after the surgery. The significant difference between the control group and the patients postsurgery could be explained with the same reason there is a significant difference in these two groups scored with the FAP as described before. However, The CPS shows also a significant difference between the control group and the patients before the surgery. These patients were considered not to be in much pain, which shouldn't allow the pain scores to be significantly different between the control group and the patients before surgery. In this case, it is important to analyse the height of these particular pain scores. The maximum pain score of the control group is 1. The highest pain score in the group of patients before surgery is 5, but the maximum pain score for the CPS is 39. Therefore, 5 is still considered to be mild pain. However, more horses and horses with acute pain are necessary to analyse this part of the study even more.

Although concentrated on different types of pain a significant difference in pain score between a control group and patients has been found in the literature for both the CPS and the FAP. Van Loon and van Dierendonck (2015) found a significant difference in pain scores for both pain scales between a control group and acute colic patients. However, only the CPS showed a significant difference between the conservative treatment and the surgical treatment. This study used more patients and used patients with different levels colic (conservative or surgical treated), but outcome is similar to the results of this study. The outcome would suggest that the CPS is more sensitive for the evaluation of pain in horses. However, a follow-up study from van Dierendonck and van Loon (2016) found a significant difference for the CPS and the FAP between the control group and the acute colic patients and also between the patients that needed a conservative treatment or a surgical treatment. Besides, the FAP shows in this study in general better results than the CPS. Another study from van Loon and van Dierendonck (2017), that found a significant difference for both pain scales between a control group and horses with acute or postoperative pain originated from the head, could support that both pain scales are usable for the evaluation of different types of pain in horses.

5.7 Effect over time in horses undergoing orthopaedic surgery

An effect over time would be interesting to analyse to find out whether there is a pattern in the progression and revalidation of the horses with orthopaedic injuries. It could help with the management of pain and the analgesic treatment of the patients. In this study, there has not been found an effect over time in horses that were admitted for orthopaedic. It is important to realise that the amount of horses used to analyse an effect over time is very low in this particular study (N between 3 and 9 for the different moments from the study schedule). It could be plausible that a significant outcome would have appeared if more horses could have participated. Besides, the very few horses that were used in this study had mild injuries and most of the surgeries were minimal invasive. If the pain scores were higher a better effect of time could have probably been evaluated because there would have been a bigger difference between before surgery and after surgery and between before pain medication and after pain medication.

However, a significant decrease over time was found for both pain scores, FAP and CPS, in a study from van Loon and van Dierendonck (2015) in which the effect over time was analysed in horses with acute colic. Three moments of time were used, which are the first time the horse arrived at the clinic, the first morning after admission and the second morning after admission. 13 horses participated in this study and the pain scores were found between 0 and 16 for the CPS and between 0 and 8 for the FAP. This means they used more horses, but more important the pain scores were relatively higher than in this study. Besides, the study from van Loon and van Dierendonck used less moments of time to analyse than this study. It could be that a significance showed up if less moments of time were used.

5.8 Shortcomings of this study

In general, as researcher and writer of this study I am pleased with the process and the outcome of this study. Some promising results were found and this study could be used for follow-up studies. However, this study has suffered some shortcomings as well.

First and most important, ten healthy pain free control horses and ten patients that were admitted for orthopaedic surgery were used for this study. From these ten horses, not all the data needed was collected, because some horses were allowed to leave the clinic before the three days postsurgery or were not allowed to leave their box during recovery. This resulted in relatively little data to analyse. More patients are needed to substantiate some of the conclusions that were made in this study so far. Some of the results from this research were close to significance and more data could be the last step to a distinct significance.

Second, all the patients participated were not considered to have major injuries or to be in acute pain. In this study, it is not possible to say something about the efficacy of both the pain scales on horses with major orthopaedic injuries. However, it was the purpose of this study to analyse mild orthopaedic pain with pain scales. Nevertheless, it would be interesting to do a follow-up study with major orthopaedic injuries and compare the results. For example, the effect of Metacam could have been analysed better if the horses were in more pain, especially for the CPS.

Third, in this study the observers were aware of the clinical diagnosis and clinical treatment of the patients. This means that the observers could have unintentionally used this information while scoring the patients. A double-blinded study design would be a solution for this problem. The observers won’t know anything about the patients and can therefore score them only on their behaviour. Bussières et al. (2008) used a double-blinded study on horses with acute orthopaedic pain. The observers scored the horses with video recordings, but the real-time assessor was blinded inside control and experimental groups. They described the inter-observer reliability and analysed the different parameters of the CPS. Although it was double-blinded a good inter- and intra-observer reliability was found ($0.8 < K < 1$). Another important shortcoming concerning observers is the number of observers participating in this study and their background. In this study only two observers were used and both have similar equine and veterinary background, because the purpose of this study was to analyse the reproducibility of the pain scales with observers with veterinary background. More observers with different backgrounds could however clarify the efficacy of the two pain scales even better. Eventually it would be convenient if these pain scales are usable for any individual that is interested, not only veterinarians. Besides, a pain scale as used in this study could make horse owners aware of the hidden signs of pain in their horse's behaviour, which could optimise the connection between the horse and the owner.

Lastly, the environment has a big influence on the behaviour of the horse (Seibert et al., 2003). Therefore, the pain that a horse shows could have been decreased due to a different environment (Taylor et al., 2002). All the patients came into the clinic for their orthopaedic surgery, which means that all the horses experienced a new environment during their stay. A new environment and new people (nurses and veterinarians) could make the horse nervous and pain could be suppressed. Besides, in this study, the observers were standing outside the box while scoring the horse, which could also influence the behaviour or the horse. Therefore, video scoring could be a solution. For example, the owner could make a video recording of the horse for the veterinarian if the owner is uncertain about the horse's health. However, if the horse needs to visit a clinic for a treatment a different environment can't be prevented. Nevertheless, video recording could still be of use. If the horse is alone in its box it will be more tempted to show its pain behaviour than around people (Taylor et al., 2002). In this study, video recordings were made by the observers from inside the box. The advantage of the video recording is not effective if the observers are still in the box to record the video. Besides, the quality of the video recording was very bad in this study. A steady video recording from one side of the box, recording the full horse, is needed to obtain a good quality. Sound and the outside view from the box are necessary too, because as an observer you need to know if a certain behaviour pattern is shown because of environmental factors or pain.

6 Conclusion

Both the use of the Facial Assessment of Pain (FAP) and the Composite Pain Scale (CPS) improve the reliability of the evaluation of pain in horses undergoing orthopaedic surgery, but the FAP is more effective compared to the CPS. Because of acceptable inter-observer reproducibility for mild pain scores in horses with orthopaedic injuries the pain scales are usable by different observers. Therefore, both pain scales are reproducible instruments for objective pain evaluation in horses undergoing orthopaedic surgery. However, the FAP shows a weak inter-observer reliability for the video recordings. Different technique in recording is needed to improve the inter-observer reliability. Lastly, the FAP is more than the CPS able to distinguish between pre- and postoperative conditions concerning different types or orthopaedic injuries. Besides, the FAP showed a significant decrease of pain scores after the administration of pain medication compared to before the pain medication. In general, more patients and observers are needed to substantiate the conclusions and generalize the outcome. Nevertheless, objective pain recognition in horses after orthopaedic surgery can be of major benefit in optimizing pain treatment and can improve outcome.

7 Acknowledgements

First, I would like to thank dr. J.P.A.M. (Thijs) van Loon and F.M. (Filipe) Serra Bragança, my two supervisors, for assisting me in any way I needed. Second, I would like to thank dr. J.C. (Janny) de Grauw for calling me whenever a new potential patient arrived at the clinic. Lastly, I would like to thank Marije Grift for helping with collecting data.

8 Attachments

8.1 Consent form

Universiteit Utrecht

[Patiënten sticker plakken]

De eigenaar of de vertegenwoordiger van de eigenaar, hiermee aangeduid als Client, van het paard aangeduid op de patiënten-sticker, hierna aangeduid als Patiënt, geeft toestemming aan het onderzoeksinstituut, de Universiteitskliniek voor Paarden (UKP), Faculteit Diergeneeskunde, Universiteit Utrecht, hierna benoemd als Kliniek, om de verkregen gegevens van pijnscoring te gebruiken voor de volgende doeleinden en onder de volgende condities:

1. Onderwijsdoeleinden.
2. Onderzoeksdoeleinden.
3. De Kliniek zal geen gegevens verschaffen aan derde partijen die zijn te herleiden tot de Patiënt en/of de Client, noch zal het deze gegevens beschikbaar stellen aan het publieke domein.
4. De video opnamen die zijn gemaakt gedurende het onderzoek en waarop de Patiënt en/of Client op enigerlei wijze herkenbaar zijn, zullen slechts gebruikt worden voor een retrospectieve visuele controle van de verkregen gegevens en zullen niet gedeeld worden met enige andere partij. Deze opnamen kunnen in voorkomende gevallen alleen gebruikt worden voor onderwijs- en/of onderzoeksdoeleinden binnen de Kliniek.

Door onderstaande ondertekening ga ik akkoord met de boven beschreven procedure.

Ondertekening Client,	Ondertekening Kliniek,
______________________________	______________________________
Naam:	Naam:
Datum:	Datum:

8.2 General anaesthesia schedule

	Premedication	Induction	Maintenance	Other medication
Patient 1	- Domosedan IV - Morfine HCl IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Cronyxin IV
Patient 2	- Domosedan IV - Dolorex IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Metacam IV
Patient 3	- Domosedan IV - Dolorex IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Metacam IV
Patient 4	- Domosedan IV - Dolorex IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Cronyxin IV - Ampi-dry 5000 - Procapen IM
Patient 5	Sedation + local infiltration	Sedation + local infiltration	Sedation + local infiltration	Sedation + local infiltration
Patient 6	- Domosedan IV - Vetranquil IV	- Diazepam IV - Narketan IV	- Narketan - Anaesthesia inhalation with Isoflurane	- Cronyxin IV
Patient 7	- Domosedan IV - Dolorex	- Diazepam IV - Narketan IV	- Domosedan - Narketan - Anaesthesia inhalation with Isoflurane	- Metacam IV
Patient 8	- Domosedan IV - Morfine HCl	- Diazepam IV - Narketan IV	- Domosedan - Chirocaine - Anaesthesia inhalation with Isoflurane	- Cronyxin, catheter
Patient 9	- Domosedan IV - Dolorex IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Metacam IV - Benzylpenicillin Na Sandoz - Procapen IM
Patient 10	- Domosedan IV - Dolorex IV	- Diazepam IV - Narketan IV	- Domosedan IV - Anaesthesia inhalation with Isoflurane	- Metacam IV

- Detomidine (CRI) (Domosedan 10 mg/ml)
- Morfine HCl (10 mg/ml)
- Butorphanol Tartrate (Dolorex 10 mg/ml)
- Acepromazine (Vetranquil 10 mg/ml)
- Diazepam (5 mg/ml)
- Ketamine (Narketan, 100 mg/ml)
- Bupivacaine (Chirocaine 2.5 mg/ml)
- Ketoprofen (Cronyxin 50 mg/ml)
- Meloxicam (Metacam 20 mg/ml)
- Benzylpenicillin (Procapen 300 mg/ml)

- IV = Intra-venous
- IM = Intra-muscular

8.3 Scoring table for pain scale scores of patients

Horse: Observer:

Day	D-1	D-1	D0	D1	D1	D1	D1	D1	D2	D2	D2	D2	D2	D3	D3	D3	D3	D3
Before/after QHorse	Before	After		Before	After	Before	After		Before	After	Before	After		Before	After	Before	After	
Before/after medication				Before	Before	After	After	After	Before	Before	After	After	After	Before	Before	After	After	After
Date	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Time	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
FAP																		
Head																		
Eyelids																		
Focus																		
Nostrils																		
Corners mouth/lips																		
Muscle tone head																		
Flehming/yawning																		
Teeth grinding/moaning																		
Ears																		
Total .../18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18	/18

Day	D-1	D-1	D0	D1	D1	D1	D1	D1	D2	D2	D2	D2	D2	D3	D3	D3	D3	D3
Before/after Qhorse	Before	After		Before	After	Before	After		Before	After	Before	After		Before	After	Before	After	
Before/after medication				Before	Before	After	After	After	Before	Before	After	After	After	Before	Before	After	After	After
Date	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Time	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
CPS																		
Kicking at abdomen																		
Pawing on the floor																		
Head movement																		
Appearance																		
Posture																		
Appetite																		
Sweating																		
Interactive behavior																		
Response to palpation																		
Respiratory Rate																		
Heart Rate																		
Rectal temperature																		
Digestive sounds																		
Total .../39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39	/39

D-1 = Pre-surgery
D0 = Day of surgery
D1 = First day post-surgery
D2 = Second day post-surgery
D3 = Third day post-surgery

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