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The Sensitivity and Specificity of Auricular Diagnosis in Horses

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ABSTRACT

The author previously observed the presence of localized tender points on the concave surface of the external auricle of horses with clinical signs of localized somatic pain. No similar point sensitivity was detected on the auricles of horses that were free of pain. The objective of this descriptive clinical study was to compare the presence or absence of auricular point pain with conventional physical examination findings to determine the validity of auricular diagnosis to predict when musculoskeletal pain was present or absent in the horse. One hundred performance horses of both sexes and varying ages and breeds, presented for locomotor problems were randomly selected from the author's clinical practice. All horses first received palpation of the concave surface of the auricle (external ear) with either the medial or lateral edge of the thumb and the results were recorded. After the auricular examination, a complete conventional musculoskeletal and orthopedic examination was performed to detect pain of the head, body and limbs. The results of the auricular and conventional examinations were then compared. Good correlation ($> 70\%$ in both sensitivity and specificity) between the auricular diagnosis and the conventional examination was found in the head, low cervical region, shoulder, the upper and lower thoracic regions and lumbar and sacral regions. No conclusions could be drawn regarding the reliability of auricular diagnosis for other regions. The findings of this study indicate that auricular diagnosis may be a useful tool in clinical practice and support the theory that auricular points represent specific reflex connections between the auricle and corresponding somatic areas.

Keywords: Ear acupuncture, horse, locomotor apparatus, clinical diagnosis, musculoskeletal pain

Auricular or ear acupuncture is based on the theory that the auricle or outer portion of the ear is a microsystem of acupuncture points that have reflex connections to specific areas of the body.¹ In the 1950's a French physician, Dr. Paul Nogier, detected auricular acupoints in humans using both electronic acupoint detectors as well as the pain reactions of patients to locally applied pressure when dysfunction was present in a specific body location.^{1,2} He suggested that the auricular acupoints were a somatotopic representation of the entire body and head arranged in the shape of an inverted fetus, but this original model has been questioned by other human researchers.³ Dr. Nogier stimulated the auricular acupoints with needles, electricity and light to treat

disease, a technique he called auriculotherapy.^{1,2} Since that time auricular acupuncture has been used in humans to treat many different conditions including pain.^{3,4}

In the 1980's using similar techniques to Nogier's, the author studied auricular points in dogs and found that like in humans, these points also related to particular body parts, organs and functions.⁵⁻⁷ While no pressure-sensitive points could be detected in healthy dogs, it was found that when dogs became ill or in pain, certain points became sensitive to the pressure of a detection probe. These studies suggested that a particular point sensitivity could be diagnostic for acutely painful and inflammatory conditions at specific body locations, but less diagnostic with chronically painful and degenerative lesions.^{5,6,8} Auricular acupoints have been used to treat several

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conditions including locomotor disturbances, epilepsy, intervertebral disk disease and acute hepatic injury.^{7, 9-14}

The location of some auricular points have been described in horses and cattle, but their diagnostic use has not been investigated in detail.^{9,15-17} In clinical practice, the author applied auricular digital palpation and observational methods to over 400 horses and found that specific auricular point areas could be located and were related to various parts of the body (Figure 1).¹⁸ The diagnostic usefulness of the auricular points was

suggested by observing a pain reaction when digital pressure was applied to a particular auricular region when pain or inflammation was present in the specific somatic location.¹⁸ Thus the possibility of auricular diagnosis for localizing somatic pain in horses was considered.

The objective of this study was to compare the presence or absence of auricular point pain with conventional physical examination findings to determine the sensitivity and specificity of auricular diagnosis to predict when musculoskeletal pain was present or absent in the horse.

MATERIAL AND METHODS

For this study, 100 performance horses of both sexes (mares and geldings) and varying ages and breeds that presented for locomotor problems were randomly selected from the author's clinical practice (Table 1). Client complaints included stiffness, intermittent gait abnormalities, bucking, rearing, hitting obstacles during jumping, poor extension in dressage horses and overall poor performance. Horses were excluded if there was obvious trauma or lameness, a known previous diagnosis, generalized somatic pain or internal, neurological or skin diseases that would localize a problem prior to the auricular diagnosis or if a complete auricular and conventional clinical examination could not be carried out because they were fractious. Horses were included in the study if they had non-localizing complaints, had not recently received analgesic and anti-inflammatory medication, and in which complete auricular and clinical examination could be performed.

Prior to the clinical examination, the entire internal

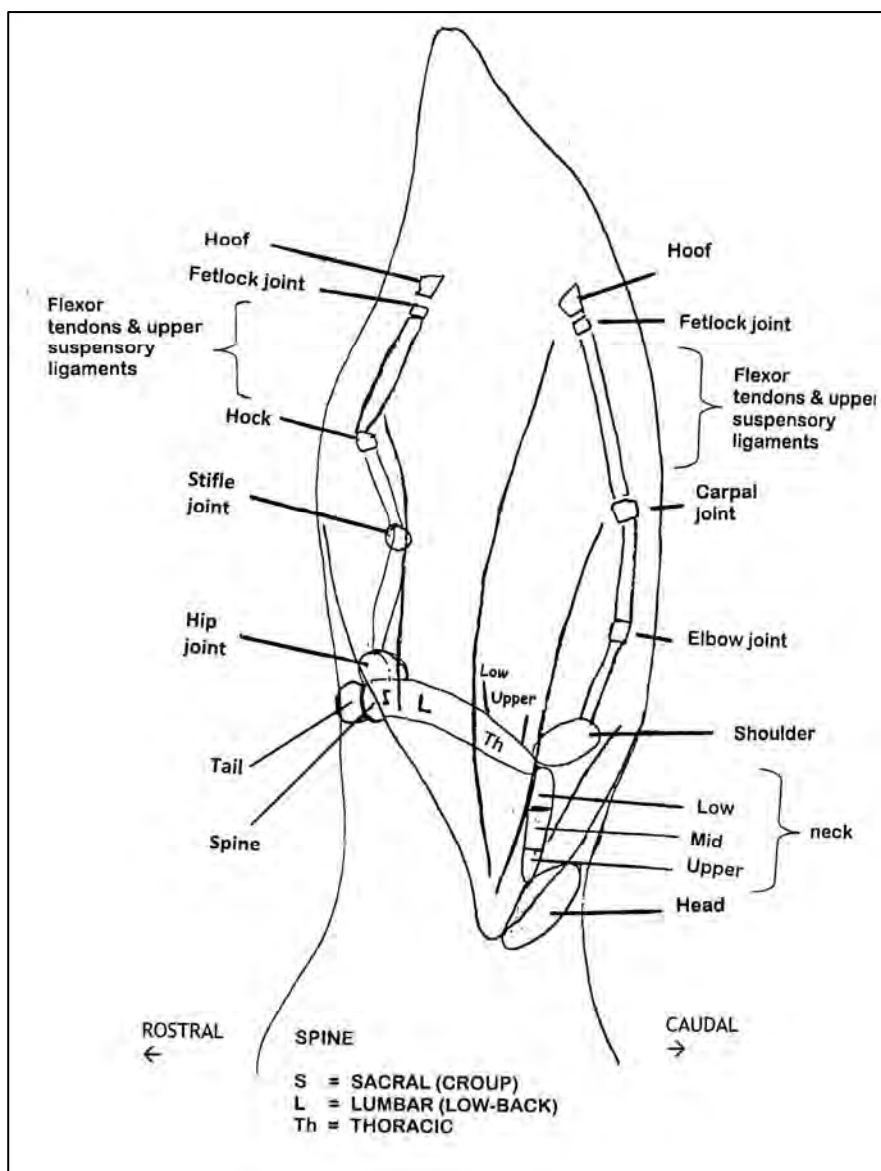


Figure 1: The proposed location of the auricular diagnostic acupoints in the horse from the examination of > 400 horses

Table 1: Signalment and performance activity of the 100 horses included in the study

Age	Range 3-17 years	Mean 8.5 years					
Breed	Thorough-breds (89)	Warm-bloods (5)	Ponies (3)	Arabians (2)	Cross bred (1)		
Sex	Mares (31)	Geldings (69)					
Activity	Show jumping (69)	Mixed disciplines (14)	Dressage (8)	Endur- ance (4)	Racing (2)	Eventing (2)	Polo (1)

Note: number of horses in each group is in parentheses

(concave) surface of both external auricles was examined, using firm pressure with the lateral or medial angle of the examiner's thumb (Figure 2). A point was determined to be painful if the horse made a definitive withdrawal of his head, when pressure was applied to the area, but not to other areas of the auricle. Whenever there was no such



Figure 2: Auriculodiagnostic examination of the equine external auricle using firm pressure with the lateral or medial angle of the thumb

withdrawal reaction, the auricular examination was considered to be negative. The point region was noted and the tentative somatic location of the problem was made based on the author's previously determined auricular point chart (Figure 1).

Once the auricular examination was completed and recorded, the horses were examined and a detailed musculoskeletal examination was performed in a previously described conventional manner.¹⁹ Structures of the musculoskeletal apparatus including appendicular joints (shoulder, elbow, carpus, front and rear fetlocks, hip, stifle and hock), front and rear tendons and the upper suspensory ligaments, hooves and head were carefully palpated and repeated adverse or withdrawal reactions by the horse were interpreted as a positive pain response. The upper, middle and lower cervical vertebral regions, the cranial (withers) and caudal thoracic vertebral regions and the lumbar and sacral regions and tail were thoroughly examined and palpated for pain. Lower limb joints including the fetlock, carpus, elbow, hock and stifle joints were flexed and rotated whenever applicable and any sign of pain or discomfort was noted. All four hooves were evaluated with a hoof tester for the presence of pain. The location of pain at specific regions of the head, body or limbs was noted (Table 2).

The results of the auricular and the conventional examinations were then compared to determine the correlation between the two methods. The findings were assigned to one of 4 categories (Table 3). A true positive (TP) result was obtained when pain was detected in a particular auricular point area as well as the corresponding body part using the model shown in Figure 1. A true negative

Table 2: Incidence of pain by anatomic region and correlation with auricular acupoint pain and the sensitivity and specificity of auricular diagnosis

Anatomic region	Horses with pain (n)	TP (n)	TN (n)	FP (n)	FN (n)	Sensitivity (%)	Specificity (%)
Head	23	18	76	1	5	78	99
Neck							
Upper	22	12	75	3	10	55	96
Middle	4	3	95	1	1	75	99
Lower	27	20	68	5	7	74	93
Thoracic Limb							
Hoof	9	0	87	4	9	0	96
Fetlock	3	1	95	2	2	33	98
Tendons*	16	7	80	4	9	44	95
Carpus	6	4	93	1	2	67	99
Elbow	15	9	82	3	6	60	96
Shoulder	26	23	66	8	3	88	89
Back							
Upper thoracic	26	20	70	4	6	77	95
Lower thoracic	28	19	69	3	9	73	96
Lumbar	31	24	60	9	7	77	87
Sacral	48	41	47	5	7	85	90
Tail	2	1	98	0	1	50	100
Pelvic Limb							
Hoof	7	3	93	0	4	43	100
Fetlock	1	1	99	0	0	100	100
Tendons*	5	2		3	3	40	97
Hock	4	2	95	1	2	50	99
Stifle	6	1	91	3	5	17	97
Hip	18	9	75	7	9	50	91

*including upper suspensory ligaments; n = number of horses; TP = true positive; both auricular acupoint and corresponding body part were painful (Figure 1); TN= true negative; both auricular acupoint and corresponding body part were not painful; FP = false positive; the auricular acupoint was sensitive but no pain was found in the corresponding body part (Figure 1); FN = false negative; the auricular acupoint was not sensitive but pain was found in a body part; Sensitivity (%) = TP/(TP + FN) X 100; Specificity (%) = TN/(TN+FP) x 100.

(TN) result was obtained when no pain was found in the auricular point and the corresponding body part. A false positive (FP) was obtained when a particular

auricular point demonstrated pain, but the corresponding body part did not. A false negative (FN) was obtained when an auricular point was not

Table 3: Diagnostic categories for the comparison of auricular acupoint pain and pain in a body part

Category	Auricular Acupoint Pain	Pain in a Body Part
True positive (TP)	Positive	Positive
True negative (TN)	Negative	Negative
False positive (FP)	Positive	Negative
False negative (FN)	Negative	Positive

painful, but pain was detected in a body part. Both left and right auricular acupoints had to be painful, if bilateral pain was detected on the conventional examination, in order to be classified as a TP result. If unilateral somatic pain was found, the ipsilateral corresponding auricular point had to be painful for the pair to be placed in the TP category. Most of the horses had several painful auricular acupoints as well as several sites of somatic pain, so the painful auricular point locations were paired with the appropriate somatic pain locations determined from previous observations (Figure 1).¹⁸

Sensitivity, defined as the probability of a positive test result among patients with disease and specificity, defined as the probability of a negative test result among patients without disease, were the statistical measures used in this study. The sensitivity and specificity of auricular point diagnostic capabilities were calculated by using the following formulas:²⁰

Sensitivity (%) = $TP / (TP + FN) \times 100$ (the number of true positive results divided by the total number of horses showing pain on the clinical examination)

Specificity (%) = $TN / (TN + FP) \times 100$ (the number of true negative results divided by the total number of horses not exhibiting pain on the clinical examination)

Sensitivity was used to evaluate the ability of auricular diagnosis to predict pain in specific regions of the equine musculoskeletal system.²⁰ Specificity was used to evaluate the ability of auricular diagnosis to predict that specific regions of the equine musculoskeletal system would not be painful.²⁰ Since there are four options TP, TN, FP and FN the statistical probability of a chance

finding leading to a correct somatotopic auricular diagnosis (TP) would be 25 %. It was decided that a value of > 70% for the sensitivity and specificity tests would be acceptable to consider auricular diagnosis to be a reasonably reliable method to detect pain in a particular body region.

RESULTS

A complete auricular examination was achieved in 100 horses, while it had to be aborted in another 25 horses which were not included in this study. Twenty two of these 25 horses were “head shy” or otherwise resented the auricular examination and a complete conventional examination could not be performed in the remaining three horses, because they resented detailed examination of their lower hind limbs.

Pressure-sensitive painful auricular points were detected 287 times (TP+FP) in 92 horses (average three points per horse). Somatic pain was detected 327 times in 91 horses (3-4 locations per horse). Painful somatic areas and painful auricular points were found in horses of both sexes and in different age, breed and performance categories. Data showing the incidence of pain in the auricular points and in the corresponding body parts as well as the calculated sensitivity and specificity at each site for the diagnostic auricular point in 100 horses are summarized in Table 2. One to nine painful auricular points were detected per horse in the 91 horses that also had somatic pain, while only one painful auricular point (classified as FP) was detected in one of the nine pain-free horses (11%). Ninety one out of the 100 horses (91%) displayed somatic pain in a range of 1-9 areas. The other nine horses (9%) were pain-free on the conventional clinical examination.

The somatic regions most frequently exhibiting pain were the sacral (48/100 horses or 48%) and lumbar (31/100 horses or 31%) regions (Table 2). The head was painful in 23/100 (23%) horses, while the upper and lower cervical and upper and lower thoracic regions were painful in 22/100 (22%), 27/100 (27%), 26/100 (26%) and 28/100 (28%) horses, respectively. The shoulders, hips and thoracic limb tendons and upper

suspensory ligaments were painful in 26/100 (26%), 18/100 (18%) and 16/100 (16%) horses, respectively. The number of horses with pain in the other areas was less than 10 with the lowest incidence in the pelvic limb fetlock (1/100 or 1%), tail (2/100 or 2%) and the thoracic limb fetlock (3/100 or 3%) (Table 2).

The findings of pain at each somatic site were compared to the findings of pain at the proposed auricular area (Figure 1). Findings at points and listed body parts were compared and classified as TP, TN, FP or FN. There were a total of 220 incidences of TP, 1614 incidences of TN, 67 incidences of FP and 107 incidences of FN (Table 2).

A sensitivity (TP/[TP+FN]) of > 70% was found for the head (78%), low cervical region (74%), shoulder (88%), upper thoracic region (77%), lower thoracic region (73%), lumbar region (77%), and sacral region (85%) (Table 2). Although the mid-cervical and pelvic limb fetlock regions had sensitivity > 70% the total number of horses with pain in these regions on the conventional examination was low (4 and 1 respectively) so could not provide any meaningful data.

The specificity (TN/[TN+FP]) was > 70 % in all areas, but was most significant in the head (99%), the upper cervical (96%) and lower cervical (93%) regions, thoracic limb tendons and suspensory ligaments (95%), elbow (96%), shoulder (89%), the upper thoracic (95%) and lower thoracic (96%) spinal regions, the lumbar spinal region (87%), sacral spinal region (90%) and hip (91%) (Table 2).

DISCUSSION

Since a detailed auricular or somatic examination could not be completed in 25 out of the original 125 horses (20%), some practical limitations of auricular diagnosis have to be considered. Some horses are sensitive around their heads and may not tolerate an auricular examination. As with any examination of pain that bases interpretation on response to contact like digital palpation, it is possible to misinterpret a stress reaction for a true pain response in anxious or fearful horses. To minimize misleading psychogenic reactions, the auricular and somatic examination was attempted only after the horse had been given time to become accustomed to the examiner. When interpreting a pain reaction the

temperament of the horse was also taken into consideration. One hundred detailed examinations of both the auricle and the rest of the head and body were obtained.

In this study, the pressure-induced pain of the auricular points was evaluated subjectively using a simple, practical method well suited for clinical practice. In previous dog research, the author used a spring-mounted pressure gauge to detect sensitive auricular acupoints.^{5,6,8} It quickly became evident that this method was impractical, as many horses resented the use of any detection probe in the auricular area. Digital pain detection, as used successfully by Giniaux, was selected as the most practical method for horses in this study.¹⁵ Digital palpation is widely accepted for the detection of musculoskeletal pain in equine and human clinical practice.^{19,21,22} While digital palpation is an inherently subjective method of pain detection, it is a clinically useful method routinely employed in diagnosing pain in man and animals. Subjective, digital palpation elsewhere in the body can be quite accurate with experience and the same holds true for auricular diagnosis in the horse.^{15,18} The author has > 25 years of experience in the evaluation of the musculoskeletal system of animals including the palpatory evaluation of pain and various methods of acupuncture including ear acupuncture.

Similar to the earlier findings in dogs, painful auricular points were successfully detected in horses of both sexes, as well as in horses of different ages, breeds and performance disciplines.^{5,6,8} From their observations, Giniaux and Roesti suggested some slightly different locations for the auricular diagnostic points of the lower limb joints and the hoof of the horse than observed by the author. These authors located the lower limb joints and the hoof closer to the tip of the auricle than found in this study (Figure 1).^{15,16}

In the author's previous dog research, painful auriculodiagnostic points displayed sensitivity at pressures between 90-120 g/mm², using an atraumatic spring-mounted pressure detector probe, but at least three times that pressure was necessary to produce a painful reaction at sham sites (inactive acupoints).^{5,6,8} This detection pressure is similar to the pressure used to detect painful auricular points in humans.²³

Bias in this study could have been decreased if the clinical investigations were

blinded. This would have been achieved if the auricular acupoints were evaluated by one examiner and the conventional clinical examination performed by a different examiner. This was impractical at the time, given the nature of the clinical practice from which the subjects were drawn. As well differences in palpation techniques between the two evaluators would have added another variable to the study. To try to minimize investigator bias, the auricular examination was always performed and recorded prior to the physical examination. Further studies by independent blinded investigators are needed to further validate the results of this study.

Ninety one out of 100 horses in this study had soft tissue pain of the head, neck, back, and/or shoulder muscles (Table 2). Pain at these sites is most likely explained by the fact that all the horses in the study were currently being trained in their particular performance discipline (Table 1). Active athletes, such as these horses, frequently experience soft tissue pain due to acute overtraining and muscle strain.^{19,21,22}

Test sensitivity is the ability of a test to identify diseased animals (pain in this study).²⁰ Test specificity is the ability of the test to identify non-diseased (pain-free) animals.²⁰ Good correlation (> 70% in both sensitivity and specificity) between the auricular diagnosis and the conventional examination for painful and non-painful horses was found in the head, low cervical region, shoulder, and the upper and lower thoracic, lumbar and sacral regions. Pain in these mostly well muscled areas was easy to detect; it was characterized by local muscle twitch or spasms and typical behavioral responses such as tensing or dipping of the back, withdrawal from the digital pressure or even a defensive behaviour.¹⁹ The somatic pain was moderate to severe in intensity and usually extended over a large area. It is important to remember that, in the context of this study, the pain ascribed to larger joints such as the shoulder, hip, stifle and elbow emanated from the broader somatic area around the joints themselves, including the surrounding muscles and ligaments. This peri-articular pain should be distinguished from intra-articular pain diagnosed through the use of relevant anaesthetic blocks.¹⁹ The use of these invasive techniques was not justified in these horses. It is beyond the scope of this paper to describe which particular tissues (such as muscles

or ligaments etc) were the source of the pain in individual horses.

The results of this study suggest that pain at the auricular points representing these regions of the body is a reliable indicator of pain in the corresponding body area (> 70% of the time in horses). No comparable data in horses is available in the literature and this represents the first study of its kind.

In the author's dog studies, the reliability of auricular diagnosis to detect acute inflammatory and painful processes was > 75 %, but auricular diagnosis was less accurate in chronic inflammatory and degenerative processes characterized by mild or no pain in the given organs or body parts.^{5,6} Further studies are needed to determine if the same holds true for horses. In a study of 40 human medical patients, Oleson found that auricular diagnosis could accurately predict the finding of musculoskeletal pain 75% of the time.²⁴

The reliability of auricular diagnosis to predict pain in the mid cervical region, thoracic limb hooves, fetlocks and carpi, the tail and the pelvic limb hooves, fetlocks, tendons, upper suspensory ligaments, hocks and stifles was inconclusive due to the low number of horses demonstrating significant pain in these regions. Further studies in healthy and diseased horses are needed to validate the proposed auricular diagnostic points for these body areas.

To be clinically meaningful, the auriculodiagnostic findings should be interpreted together with other diagnostic data. The presence of a painful auricular point alone does not always indicate with certainty the location of a pathologic process. Neither is it possible to derive information about the etiology of the disease from auriculodiagnostic findings. For instance, an auricular finding of sore "hoof, upper back and shoulder" does not indicate whether the conditions (as confirmed subsequently clinically) developed independently or whether the acute muscle pain and spasm in the shoulder and upper back developed as a secondary strain following the earlier painful hoof bruise. Similar conclusions regarding the limitations of auricular diagnosis were drawn in our earlier studies in dogs.^{5,6}

In the opinion of the author and other researchers, the auricular acupoints represent distant neural reflex zones, which can be useful for the purpose of clinical diagnosis as well as

therapy.^{1,2,5,6,8,10-18,23-25} Further research is necessary to better understand the clinical validity of auricular diagnosis and the corresponding physiological mechanism in numerous species, including the horse. Changes in neuronal activity in hypothalamic and thalamic regions of the brain have been noted with auricular acupoints stimulation in rats.²⁶ The high correlation between pain in auricular acupoints and regions of the body in this study supports the theory that the auricular points do represent a connection between the auricle and the corresponding somatic regions.

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