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Validation of Multidimensional Animal Pain Scale (MAPS) for Odontological Pain in Children.

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ABSTRACT

Purpouse: To develop and evaluate face, consensus, convergent and disciminative validity of a multidimensional pain scale in the pediatric dental patient.

Methods: This was a cross sectional study. Children of 5 to 11 years, both genders was included. The final instrument consisted of a cardboard with the animal figures printed on one side (butterfly, duck, dog, wolf, and dinosaur) and on the other a scale of 1 to 10. Test-retest reliability, correlation between figures and circles of different sizes and association between changes in the level of pain before a nociceptive stimulus prior to an odontological procedure were evaluated.

Results: The intraclass coefficient was 0.84 [0.69–0.89]. Multivariate analysis showed significant association independent of the sex or age, between the animal figures of the MAPS and the diameter of the circles ($p < 0.0001$), and painful stimulus ($p<0.05$). A correlation of 0.95 between MAPS and the Visual Analogue Scale was observed.

Conclusion: The scale proposed here encompasses both the affective / emotional and the somatosensory dimensions. Its reproducibility and easy application allow establishing management strategies in both dimensions of pain.

PALABRAS CLAVE
Pain,Multidimensional scale,Validity
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INTRODUCTION

Pain is considered a somatosensorial and emotional unpleasant experience with a very complex physiopathology. It is related to a real or potential tissue lesion, with visible or audible manifestations of behavior [1].
The dimensions of pain are mainly three: a) somatosensorial (nociception), that refers to perception and detection of harmful stimulus , including intensity, localization, duration, time and pain quality; b) affective-emotional, the relationship between pain and emotional state of the individual like depression, anxiety or fear and c) cognitive, related to awareness and pain memory, which are interrelated psychologically and physiologically [2 - 4]. Pain is also related to idiosyncrasy, cultural and environmental factors, such as race or sex, that explain variations in pain threshold [5,6] and genetic factors that explain a variety of differences in psychophysiological behavior towards pain [7-10].
Deeper comprehension of pain physiology intends to explain these variations starting with the initial aggression, transmission and "filtering" in the posterior horns of the spinal cord to the brain, specifically to the thalamus and the cerebral cortex where perception and awareness of pain is integrated [11].

In order to evaluate pain, cardiac response, blood pressure, sweat, tearing, temperature and lung volumes/capacities have been studied with low correlation among those parameters and pain intensity [12]. Therefore, verbal and written scales have been developed that evaluate one or more of the pain dimensions previously described.
Unidimensional scales that evaluate intensity include the verbal ones, that express intensity through adjectives (light- moderate, intense- agonizing, really intense) and its response to analgesics [13], the number scales NRS (requires the patient to rate their pain on a defined numeric scale) [14], the behavior scales just as FLACC (Face, Legs, Activity, Cry, Consolability scale), Faces Rating Scales, Facial Image Scale and the visual analogue scales VAS (faces expression different severity of pain) due to their greater correlation and sensitivity are the most used at present [15].

In children, a very few studies have examined the emotional aspect, anxiety or pain fear, since younger children are unable to complete questionnaires like the CFSS-DS (Dental Subscale of the Children's Fear Survey Schedule), being necessary to frequently use the parent's version of the CFSS-DS [16,17].

In pediatric dentistry, pain is particularly distressing as it arises from the cause and the treatment. They both are often a source of severe pain [18,19]. It has been reported as the most common complaint in children [20]; therefore, treatment that considers both somatosensory and affective-emotional aspects should be considered as a priority in any dental intervention in this age group.

Nevertheless, in daily clinical practice pain is evaluated only through the VAS scale, which preferably measures the intensity aspect, emphasizing the need for the development of a multidimensional scale in order to offer an integral management, especially in young children. Then, the present work focuses on the development and validation of both somatosensory and affective-emotional pain scale through the association of the perceived experience and an animal cartoon scale in the pediatric dental patient.

Subjects and methods:
A multi-phase validation of a diagnostic test were performed in 4 to 11 years old, any gender children, that assent to participate were included. The study was approved by the ethical committee of the stomatology school of the Autonomous University of San Luis Potosí, México. Informed and signed consent was obtained from the parents.

Face and consensus validation:
Initially for the construction of the Multidimensional Animal Pain Scale (MAPS), 10 figures were chosen by an expert consensus on the subject (one pediatrician, two pediatric dentist and one psychologist), in order for the animal features to be chosen, that represent different emotions symbolically associated to pain, resulting in a scale of 5 figures that allowed the evaluation of different degrees of emotions associated with the painful experience (duck, chicken, dog, wolf and lion). They were printed individually in 10 x 10 cm cartons. Then Eighty children (forty girls) who denied phobia or previous negative experience from these animals were asked to place in ascending order the figures that represent the affection of the "softest", "pleasant" or "beautiful" to the most "ugly", "annoying" or "painful". An independent evaluator blinded to the hypothesis of the study recorded the order in which each child accommodated the figures, on a numerical scale marked from 1 to 10. The results showed a high degree of confusion between duck and chicken to symbolize the less emotion and between wolf and lion at the upper end of the spectrum, so again the consensus of experts decided to change duck for butterfly and lion for dinosaur. The final ascending order was: butterfly, duck, dog, wolf and dinosaur (figure 1).

Figure 1. Multidimensional Animal Pain Scale (MAPS)

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The final instrument consisted of a cardboard with the figures printed in color on one side and on the other a scale of 1 to 10, covering the numbers 1 and 2 the butterfly, 3 and 4 the duck, 5 to 6 the dog, 7 and 8 wolf, and 9 to 10 dinosaur.
Then another 80 children evaluated the placement order of the figures from least to greatest. According to the above there is a theoretical total of 4 possible swaps of one degree on the scale (one place substitution or exchange of a figure from left to right or right to left) per child gives the possibility of 320 permutations in the 80 children evaluated (Forty girls). In this validation phase a total of only 18 permutations of one degree (5.6%) were found: 8 of them between butterfly and duck, 3 between duck and dog, 3 between dog and wolf and, 4 between wolf and dinosaur. In addition, there is the possibility of three second-degree swaps (substitutions of two places left or right) per child, resulting in a total of 240 possible second-degree swaps. We found 5 swaps only (2.08%): 1 between duck and wolf, 3 between butterfly and dog and 1 between dog and dinosaur. No exchanges of third or fourth grade were recorded. All the swaps happened in children below 5 years old.
Reliability is not a validity measurement but is a prerequisite for a scale to be considered rational. Reliability describes the overall consistency of a measure

under similar conditions and across time. Test-retest reliability evaluates the degree at which pain scores are consistent from one assessment to the next and was determined in 20 children with painful conditions in the general office of pediatric dentistry. The intraclass coefficient between two separate measures for 5 minutes with MAPS scale was 0.84 [0.69–0.89].

Psychometric properties of the test: a sample of fifty healthy children between 5 and 11 years were included to determine the correlation between the animal figures of the scale and five printed circles of different diameter: circle a) 8 mm of diameter, b) 17 mm, c) 23 mm, d) 33 mm and e) 53 mm. They were asked to join the figures with the circles, all mounted on a letter sheet. It was explained that both animals and circles means intensity of the stimuli: the small circle means the least stimuli and the biggest and the largest the biggest stimulus; on the other hand butterfly means the smallest or pleasant sensation, almost without discomfort or pain; duck means a little annoyance, something unpleasant or a little pain; wolf displeased or annoying pain; lion a great annoyance or a great pain and the dinosaur the greatest displeasure, fear or pain that could be imagined.

At every instance the number scale was referred, considering the emotional and painful aspect, with the purpose of covering the dimensions explained previously. Once they selected the image that better describe their emotion, the number scale was shown and they had to for pick one out of the 2 numbers that held each figure; for example, a kid that picked dog, it had to be distinguished from 5 dog or 6 dog.

The best agreement was considered when the smallest circle was associated with the butterfly and the biggest one with the dinosaur, as well as the intermediate one with the figure of the dog. To determine the proportion of the variability in the perceived intensity explained by the metric magnitude of the circles, it was analyzed by multiple linear regression, taking into account sex and age, to evaluate if the metric properties are consistent between the subgroups.

Discriminative validity: a form of content validity, which is the degree to which a test is actually measuring only the construct it is meant to measure (v.gr., pain), and not something else. In order to assess the discriminative validity of MAPS test it was applied to a odonatological process by a pediatric dentistry in three different times: before dental anesthesia infiltration using lidocaine (painful stimulus), during and 5 minutes before the puncture, but before the odonatological process. The test was made by blinded evaluators. We calculate ANOVA to compare the mean MAPS in three times, and in two different age and in 2 different age groups: children from 5 to 8 years old and from 9 to 11 years old. Children below 5 years old were excluded because of their inability to distinguish pain in any scale.

Convergent validity: it refers to the degree to which 2 different scales that are supposed to measure the same thing (eg, pain) produce similar results. We assessed convergent validity by determining correlation between VAS and MAPS by spearman Rho Test in different times of measurement. Previously it was explained to them that the VAS line is like a ruler whose left end where the number one is placed symbolizes the least pain or "most pleasant" sensation and at the other end, the number 10 is the greatest pain that can be imagined or the most "unpleasant". Among these, are the sensations that increase from almost nothing to the maximum pain. The sample size (n=50) was determined to detect a difference of 0.05 (alfa= 0.05, beta=0.90) in an expected R2= 0.90, between the two pain measures. The analysis was performed with STATA, Ver. 13.0

RESULTS:

Psychometric properties of the test

Fifty children between 5 and 11 years of age, of both sexes (25 girls) were included, in order to evaluate the correlation between the emotion evoked by MAPS figures (its numerical value behind the cardboard) and the size of the circle selected. The results showed for the butterfly figure an average size of the associated circles of 0.52 mm (CI95% = 18.8- 26.4 mm), for the duck figure and average of 18.05 mm (CI95% = 14.2-21.8mm), for dog 22.6 mm (IC95% = 18.8-26.4 mm), wolf 31.1 mm (IC 95% = 27.2-34.9 mm) and for dinosaur 50.64 (IC 95% = 46.9-54-4 mm). This suggests, the greater emotion evoked of one animal figure at MAPS scale, the bigger the selected circle´s dimension, which corroborates the proposed order of the images in the face and consensus validation.

The multiple regression analysis showed significant association independent of the sex or age, between the animal figures of the MAPS and the diameter of the circles (p=0.0001). Adjusted R2 of the model = 0.71 (table 1).

Discriminative validity

The aim was to evaluate the MAPS scale capacity to detect or discriminate changes in pain perception. the pain was evaluated with the MAPS scale before, during and at the end of the painful stimulation in children. subsequently, we calculate independent ANOVA test to compare the mean MAPS and VAS scores at three times.

Variable	b	St. Error	t	p
Intercept		-985.6	-14-14	0.000001
Age	0	0	0	NS
Sex	0	0	0	NS
MAPS (animal figures)	0.85	9.729	14.5	0.0001

MAPS and the diameter of the circles (p=0.0001). Adjusted R^2 of the model = 0.71 (table 1).

Table 1. Multivariable analysis of the association between circle dimension and an emotional stimulus by figures found MAPS scale in children.

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The children were divided into into two age groups.
Table 2 shows these results: there was a statistically significant difference between the three times, in the two age groups. The baseline measurement showed a lower mean before the puncture in both scales, increasing significantly during the painful stimulus and decreasing again at 5 minutes when the effect of lidocaine was considered present and the emotion anticipated to the stimulus had passed.
Convergent validity
In order to determine if the scale also measure the nociceptive dimension of pain, correlation between the MAPS and VAS scales were evaluated by Spearman Rho correlation test, showed values of r = 0.96 before infiltration, r = 0.95 during and r = 0.96 after it, corroborating this proposal.

DISCUSSION:

Hippocrates said ""Divine is the work of relieving pain", this quote synthesizes the importance that man granted to physical and emotional pain from its very origin, and to be able to establish a treatment first it is necessary to make a proper diagnose.
Our study presents the results of the validation of a novel multidimensional scale of pain assessment in children aged 5 to 11 years, that can be used easily in a dental care clinic, which emphasizes the affective / emotional aspect of pain, through its correlation of caricatures of animals that due to their projective content are easier to establish association for children [21].
The convergent validity did not find differences between sex and age, and could then be applied in a general way, even in children from 5 to 8 years of age. In addition, the agreement between the original VAS scale and MAPS, in the face of a real painful stimulus, indicates its ability to evaluate also the somatosensory dimension and degree of pain, which makes it possible to classify it as a multi-scale tool. Until recently the pain had been considered as a mere somatic sensation produced by a nervous stimulation, in which the emotional aspects only constituted a reaction to the presence of the pain-causing agents (physical or chemical). That is, pain = nociception. Therefore, only aspects such as pain intensity and location were taken into account for its management. At present, the motivational / affective dimension is considered as one of the most important components [22], understanding pain as a global and multidimensional experience, susceptible of study and intervention by diverse scientific disciplines [23].
The sensory-discriminative dimension is directly related to the anatomo-physiological mechanisms. It is responsible for the transmission of nociceptive stimulation from the region where there has been tissue damage, infection or any other organic or functional alteration to the higher nervous centers. This dimension is responsible for the detection of the spatial and temporal characteristics of pain, as well as the intensity and certain aspects of pain quality (eg, the distinction between burning, oppressive pain).
The affective dimension implies the subject quality of pain experience, specific in suffering aspects, such as disgust, dislike or when emotional changes are produced. Because of the aversive component of pain, the answer includes evasive actions, that will have a special meaning in future pain behavioral patterns. On the other hand the cognitive dimension is linked to the affective motivational one, and refers to the beliefs, cultural values and cognitive variables, such as auto efficacy, control perception and the consequences of pain experience [24].

Advances in the field of neurophysiology have allowed us to support the previously mentioned notions. It is well known that the main implied tracts in pain transmission are the spinothalamic tract (STT) and the spinoparabrachial hypothalamus tract. At the level of the thalamus, the STT establishes a connection with the ventral posterolateral nucleus (VPL) and the posteromedial ventral nucleus (VPM); then, the neurons of these nuclei project their axons towards the primary sensory cortex (somatosensory component of pain as intensity and location) and on the cortex of the insula and anterior cingulate cortex (affective component) respectively, in addition to its connection with the amygdala, involved in fear, memory and emotional behaviors; Therefore the primary affective responses related to pain are generated at least initially without the intervention of more complex processes and the aference of the painful stimulus is modulated by the nuclei described modifying the nociceptive perception before reaching the cerebral cortex. It is very important to recognize that the STT is directly and indirectly connected to insula cortex , which allows the brain to elaborate a global sensory representation that includes all sensory input elements, including memory and the subcortical emotional component, which had been initially activated by the SPA and SPH direct routes The insula and the posterior parietal cortex stimulate the CCA, a structure that is part of the emotional and motivational network of the brain, related to the limbic system that could have a integrative function of emotional elements, allowing the establishment of an "emotional evaluation" that defines the priorities of action, completing the action of the frontal multimodal cortex.

Although many neurotransmitters and the intervention of different neural pathways are involved in the process of the affective component of pain, dopamine, in particular, seems to play an important role, especially in the affective experience of pain [25,26].

Most current scales only partially explore dental pain, requiring a more comprehensive approach at least in children. The scale proposed here encompasses both the affective / emotional aspect and the somatosensory aspect, through the correlation of affect between figures and the magnitude of pain, based on the premise of psychophysics that establishes that different sensory stimulus produce similar psychological experiences that can be useful specially in young children where other scales fail to be used [27-30].

In the end, how much of a pain is emotional, how much is somatic and how much cognitive? Definitely, the proportion in which each one influences the perception of pain is personal and changes from patient to patient; However, given that the emotional part modulates both somato / sensory and cognitive perception, it is very convenient to evaluate all of them in any dental procedure, by means of a reproducible somatosensory and affective scale such unique instrument, as the one presented here, in order to improve and individualize therapy options, including implementing basic cognitive behavioral techniques, especially in small patients, to reduce anxiety and affective pain emotions to potentially buffer against the development of negatively biased pain memories.

More studies are needed in different populations to establish whether the same figures are applicable, as well as controlled clinical trials that evaluate multimodal therapies in pain management.

CONCLUSION:

The pain evaluation with the scale validated here, will allow strategies of multidisciplinary pain control to be incorporated in conventional dental procedures that actually only focus on treating the somatosensory dimension of pain.

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Compliance with Ethical Standards:

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest.

RESEARCH INVOLVING HUMAN PARTICIPANTS :All procedures performed in studies involving human participants were in accordance with the ethical standards of the Faculty of Stomatology research committee (05/2018) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

INFORMED CONSENT: Informed and signed consent was obtained from the parents of all individual participants included in the st**udy**.