Narrative review

Non-pharmacological strategies as adjuvants in needle associated acute pain management in pediatrics

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Estrategias no farmacológicas como adyuvantes para manejo de dolor agudo por punción en pediatría

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Abstract
Pediatric pain is a public healthcare problem present in 78 % of hospitalized patients and it is frequently associated to needles. Fast and effective controls are needed, therefore, sensory stimulation and psychological strategies have been developed. The aim of this study was to describe the use of non-pharmacological strategies as adjuvants in needle associated children pain management. A review was made searching through original articles and other reviews. Pain mechanism involves C fibers and Aδ fibers, which respond to short term needle pain. Buzzy® device is among the innovative physical strategies to relieve pain, which acts according to the pain threshold theory, diverting attention from pain to a pleasurable sensory stimulus (cold and vibration) decreasing its intensity when compared to topical anesthesia ($p < 0,001$). Meanwhile psychological strategies such as virtual reality divert the child's attention to a pleasant visual and auditory stimulus. It creates a tridimensional environment with an electronic device, decreasing pain while distracting the child when compared to the control group ($p < 0,05$). The use of innovative non-pharmacological strategies as adjuvants for needle pain management is effective decreasing children pain and reducing stress and anxiety in parents and healthcare workers.

Keywords
Needles, acute pain, pain management, patient satisfaction, virtual reality.

Resumen
El dolor en pediatría es un problema de salud pública que afecta al 78 % de pacientes hospitalizados y está frecuentemente asociado a punciones, por lo que es necesario un control rápido y efectivo. Existen en la actualidad estrategias psicológicas y físicas de estimulación sensorial para abordarlo. Se pretende describir el uso de estas como coadyuvantes en el manejo del dolor agudo por punción en pediatría. Se realizó una revisión narrativa de artículos originales y revisiones bibliográficas. El mecanismo del dolor involucra a las fibras C y a las fibras Aδ, que responden al dolor por punción. Entre las estrategias innovadoras se encuentra el dispositivo Buzzy®, que actúa mediante la teoría de compuerta del dolor, desviando la atención del dolor hacia un estímulo sensorial placentero (frío y vibración) que disminuye la intensidad en comparación con anestésicos locales ($p < 0,001$); así mismo, la realidad virtual desvía la atención del niño hacia un estímulo placentero, visual o auditivo, creando un ambiente tridimensional y produciendo analgesia por distracción en comparación al control ($p < 0,05$). El uso de estrategias no farmacológicas innovadoras como coadyuvantes para el manejo de dolor por punción son efectivas para disminuir el dolor en el paciente pediátrico, así como el estrés y la ansiedad, tanto en los padres como en el personal de salud.

Palabras clave
Agujas, dolor agudo, manejo del dolor, satisfacción del paciente, realidad virtual.

Introduction

Acute pain, one of the most frequent reasons for consultation, is defined by the International Association for the Study of Pain as an uncomfortable sensory and emotional experience associated with imminent or confirmed tissue injury[1,2]. In pediatrics, pain is an important public health problem[3], due to the sensation of discomfort, alteration of the patient's vital signs and hemodynamic parameters[4]. It has been reported that 78 % of patients suffer pain during their hospital stays, being more frequent when associated with venipuncture and intravenous insertions[5].

Inadequate pain management causes stress, anxiety, prolonged hospital stays and increased costs in a short time[6], while causing hyperalgesia, rejection of health facilities[7] and post-traumatic stress in the long term[8], causing a reduction in adherence to chronic treatments[9].

Nowadays, the gold standard in pediatrics for pain management in venipuncture procedures is topical anesthesia; however, its use is limited due to its delayed effect[10]. Since effective strategies for pain management are needed, alternative non-pharmacological methods such as virtual reality[11] and Buzzy® emerge, which immediately act by distracting the senses and can even prevent sedation[12]. Bergomi *et al.* refer that, because these methods involve different senses, they modify the perception of pain and reduce stress in the patient. Therefore, this method achieves greater adherence to procedures and treatments, especially in those that are long-term[13].

Sahiner and Bal describe that when the child is distracted by non-pharmacological strategies during venipuncture, they reduce the sensation and perception of pain and anxiety in both the patient and the parents[14], achieving a positive effect since adverse effects are presented[15] and hospital stay is reduced[16]. Therefore, their objective is to describe the use of these non-pharmacological strategies as adjuvants in the management of acute pain associated with puncture in pediatrics.

Discussion

Mechanism of the area of puncture pain

Pain is a multisensory and complex phenomenon that requires a complete evaluation for proper management[17]. It is classified into inflammatory, neuropathic and nociceptive; the latter is subdivided into visceral and somatic pain, which is perceived by stimulating pain receptors (nociceptors) distributed in skin, muscles, joint capsules, bones and some organs, activated by mechanical, chemical or thermal damage[18].

Pain perception is the result of multiple and dynamic mechanisms which belong to the central nervous system (CNS) and the peripheral nervous system (PNS), which inhibit or facilitate stimulation and pain response[19]. When the nociceptors are stimulated, sensory information is transmitted to the dorsal ganglion and subsequently to the laminae I to V of the gelatinous substance in the dorsal horn of the spinal cord, where the axon of the second-order neuron is decussed. Then, this information ascends on the opposite side, through the anterolateral fascicles in the spinothalamic tracts. Afterwards, it is processed in the medial and lateral nuclei of the thalamus. Finally, the message is sent to the somatosensory cortex through the third-order neuron, where the intensity and location of the lesion are perceived[11].

As to the mechanism of puncture pain, it involves the two main types of pain receptors, which are the unmyelinated C fibers, slow conduction velocity (0,5-2 m/s), responsible for 70 % of afferent information, whose response is poorly localized and the myelinated Aδ fibers, fast conduction velocity (5-15 m/s) and localized response, that respond to pain by puncture of short duration[20].

Among the inflammatory mediators involved in the emission or continuation of the painful signal in the ascending pain pathway are 5-hydroxytryptamine, hydrogen ions, cytokines, bradykinin, histamine, prostaglandins and leukotrienes. Signal transmission is inhibited or attenuated through inhibitory downstream pathways by endogenous opioids and cannabinoids, gamma aminobutyric acid, cholecystokinin and nitric oxide[11].

Nowadays, needle procedures are indispensable because they are necessary for diagnosis, treatment and prevention of pathologies, so people are exposed to them from birth[21]. The pain associated with venipuncture is one of the most intense, uncomfortable and stressful experiences for pediatric patients[22,23]. Orenius *et al.* conducted a study that showed that 21 to 75 % of pediatric patients suffer fear and phobia of needles[24]. The procedures frequently involved are: intravenous canalization, intramuscular injection, subcutaneous injection and lumbar puncture[25].

Non-pharmacological strategies for pain management

A study conducted in the United States of America reports that 80 % of pediatric pain management medications are for "off-label" use[26], showing that oligoanalgesia exists as compared to the adult population[27]. In the absence of effective drugs for the production of analgesia in pediatric patients, there is a need to use non-pharmacological strategies as adjuvants in pain management in the child population.

These non-pharmacological techniques are divided into physical, such as massage, vibration, hot compresses, comfort repo-

sitioning, ice placement or physical and psychological activities, which include behavioral strategies, such as relaxation and distraction through visual or auditory stimulation[28]. The combination of at least two of these is more effective than their individual use[29].

Regarding the role of sensory stimulation devices in pain relief, physical strategies are based on the modulation of pain sensation, transmitted by the Aδ and C fibers, by non-harmful stimulation of thermoreceptors (temperature) and mechanoreceptors (Aβ fibers, pressure, vibration and fine touch), activating inhibitory interneurons that block the afference of the painful signal, a phenomenon known as the gate control theory of pain[30].

The mechanism of action of the Buzzy® portable device consists of mechanical stimulation combined with sensory stimulation through cold measures such as the application of ice that blocks pain on contact[31]. This device does not use drugs and is adjustable by means of an elastic band close to the puncture site and can be combined with mechanical sensory measures such as vibration, which increases the pain threshold producing hypoalgesia at the site of injection[32]. The variety of these devices consists of the combination of stimuli and medical grade material that allows disinfection in those used in patient care areas as opposed to those for home use[31].

Psychological or cognitive distraction techniques act diverting the child's attention from the harmful stimulus to a pleasant one through the senses of sight, touch and hearing, with the ideal distractor being the one that manages to stimulate them simultaneously[33]. Nowadays, the use of virtual reality (VR) as a therapeutic tool[34], has been implemented, which consists of the creation of an artificial environment in three dimensions through the use of a computer or cell phone, connected to a visor adjusted to the child's head, its main mechanism is the simulation[35] which plays *Aqua, Virtual Reality Gorilla Exhibit,* or interactive games such as knocking down teddy bears with balls[33].

Virtual reality allows the user to experience immersion in a three-dimensional environment generated by computer[36], which has proven to be effective in relieving acute pain associated with punctures, dressing changes in second and third-degree burns and in post-surgical cardiovascular recovery. However, the specific mechanism for action has not yet been determined[37].

Buzzy®, virtual reality and traditional techniques

Non-pharmacological techniques of the physical type include the Buzzy® portable device, whose effectiveness in relieving pain continues to be tested.

AlHareky *et al.* conducted a study in Saudi Arabia with 74 children from 5 to 12 years old, whose objective is to compare the intensity of pain by maxillary block, infiltrating local anesthesia (traditional technique) as a control group, against the group treated with local anesthesia plus the Buzzy® device, finding that, based on the visual analog scale (VAS), the intensity of pain in the treated group (6,68) was lower than in the control group (8,42), a statistically significant difference ($p = 0,001$). Similar data were reported when using the face, legs, activity, crying and consolability (FLACC) scale, according to which the treated group expressed less pain (5,92) as compared to the control group (8,16), with a p-value of 0,002, showing that adherence to the device considerably decreased the intensity of pain associated with puncture in children[38].

These results are consistent with what was reported in the study of 50 children from five to ten years old in India, who found a significant reduction in the perception of pain associated with the application of local anesthesia in dental procedures according to the FLACC scale (treated: 1,4 and control: 3,96; $p \leq 0,05$) with the use of the Buzzy® device compared to the perception evaluated according to the Wong-Baker face scale (WBFPRS) (treated: 5,68 and control: 6,15; $p \leq 0,05$)[39].

Bilsin *et al.* also found that the use of the Buzzy® device two minutes before the procedure reduces the intensity of pain associated with the application of local anesthesia prior to tooth extractions, in a study conducted in Turkey with 60 children aged 6 to 12 years old, using the WBFPRS scale (treated: $0,86 \pm 1,13$ and control: $3,33 \pm 1,91$; $p < 0,05$) a mean difference of 2,47 points in favor of the treated group was shown[40].

The aforementioned studies differ from the results obtained by Yilmaz *et al.*, who included 60 children between 8 and 16 years old, since they did not find statistically significant difference in the intensity of pain after peripheral venous catheterization with the use of the Buzzy® device between the experimental group and the control group[41].

In Italy, a study was conducted which showed that the use of a non-pharmacological technique of a physical type in conjunction with a distraction method decreases the perception of pain. 72 patients

from 3 to 10 years old were included in order to compare the level of pain associated with puncture in two study groups: a treated group, using the Buzzy® device in conjunction with distraction cards, and as a control group, using the hospital's routine distraction technique. Pain was lower in the intervention group with the device than in the control group according to the VAS scale (treated: 3,65 ± 2,011 and control: 4,67 ± 2,14; p < 0,05; CI 95 %)[42].

Non-pharmacological techniques have not shown the same efficacy when applied in isolation, compared to the use of topical anesthetics, such as lidocaine patches for the reduction of puncture pain, being this evidenced in a study carried out in three vaccination centers in France with 220 patients from 4 to 15 years old, where they demonstrated that the Buzzy® device was not equivalent to the placement of lidocaine patches in the prevention or reduction of pain associated with intramuscular injection[43].

Özalp Gerçeker *et al.* evaluated the effect of two different virtual reality methods (VR-Rollercoaster y VR-Ocean Rift), on pain associated with blood sampling in 136 children aged 5 to 12 years old. The pain intensity of the patients was measured using the Wong-Baker faces pain rating scale (WBFRPS), which showed that mild pain values (1-3 points) were reached in both virtual reality groups when as compared to the control group, which maintained moderate pain (4-6 points) (VR-Rollercoaster 1,2 ± 2,2; VR-Ocean Rift 1,0 ± 1,5; control: 4,1 ± 3,5; p < 0,05). However, there was not statistically significant difference between the two groups that used virtual reality[44].

The results mentioned before contrast with those obtained in a study carried out in 59 children from 8 to 17 years old at a hospital in Ontario, Canada, which reported that the use of virtual reality compared to distraction by television or "Child Life" interventions program, represented a statistically significant decrease in fear of pain, but did not significantly affect pain intensity[45].

The effect of distraction cards, virtual reality and the Buzzy® device on puncture-associated pain in 142 children aged 7 to 12 years old was evaluated in a study in a peripheral venous canalization hospital unit in Turkey. The researchers measured the pain intensity reported by the patient using VAS. The study revealed that the Buzzy® group (VAS 2,2 ± 2,0) had the lowest average pain, followed by the virtual reality group (VAS 2,7 ± 2,8), the distraction cards group (VAS 3,4 ± 2,4), in contrast to the control group (VAS 5,2 ± 2,8). There was statistical significance among all intervention groups versus the control group (p < 0,05). There was not significant difference between Buzzy® and virtual reality[46].

Satisfaction of innovative non-pharmacological techniques

Redfern *et al.* evaluated the satisfaction of parents in 50 children when using Buzzy® compared to no intervention during vaccination in Spain. When used a visual scale by faces to measure anxiety, they found that Buzzy® did not decrease fear or anxiety about vaccines according to parents (intervention: 4,34 ± 3,4, control: 4,58 ± 1,6; p < 0,05)[47].

In Turkey, the perception of the vaccinating nurse when using Buzzy® and its impact on the WBFPRS scale and Children's Fear Scale (CFS) in two groups of 45 first-grade school children was evaluated in a study finding that the device decreased pain (experimental: 1,86 ± 1,61; control: 5,46 ± 1,97, p < 0,05) and fear (experimental: 1,42 ± 0,62; control: 1,77 ± 0,7, p < 0,05) according to healthcare personnel [48].

In Australia, Chan *et al.* conducted a study to verify the impact of VR on standard management to decrease pain during venipuncture and parental perception during procedures; therefore, they used the VAS scale in the emergency department, finding that on average the intervened group expressed lower pain intensity, with a mean difference of 4 points as compared to 1 point in the control group (p < 0,05)[49]

In a sample of 58 individuals aged 4 to 15 years admitted to a hospital in Spain, the perception of pain (using WBFPRS in patients aged 4 to 6 years, VAS in patients aged 7 to 15 years) and fear (CFS) in children was rated through the parents and health care staff. The population was divided into control group, VR group and VR group plus traditional technique. The results indicate that VR decreased the median intensity measured by the pain scales, according to parents (control: 4 of 5 points, VR: 2 of 5 points, VR plus traditional technique: 1 of 5 points; p < 0,001) and health personnel (control: 4 of 5 points, VR: 2 of 5 points, VR more traditional technique: 0 of 5 points; p < 0,001), as well as on the fear scale, according to parents (control: 3 of 4 points, VR: 1 of 4 points, VR plus traditional technique: 1 of 4 points; p < 0,001), and according to health personnel (control: 3 of 4 points, VR: 1 of 4 points, VR with traditional technique: 0 of 4 points; p < 0,001)[50].

It has been shown that both health personnel and parents report a decrease in anxiety, fear and pain in patients.

Conclusions

The use of non-pharmacological strategies such as Buzzy® and virtual reality, for pain management in pediatrics, are effective in puncture procedures, since they present lower intensity score in the different pain scales compared to the non-intervened groups. Also, they have no adverse effects, and are ideal for emergency units due to their short time to take effect.

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