JCN Journal of Clinical Nursing

Journal of Clinical Nursing

ORIGINAL ARTICLE

Effect of virtual reality distraction on pain among patients with hand injury undergoing dressing change

Chunlan Guo, Hongyan Deng and Jian Yang

Aims and objectives. To assess the effect of virtual reality distraction on pain among patients with a hand injury undergoing a dressing change.

Background. Virtual reality distraction can effectively alleviate pain among patients undergoing a dressing change. Clinical research has not addressed pain control during a dressing change.

Design. A randomised controlled trial was performed.

Methods. In the first dressing change sequence, 98 patients were randomly divided into an experimental group and a control group, with 49 cases in each group. Pain levels were compared between the two groups before and after the dressing change using a visual analog scale. The sense of involvement in virtual environments was measured using the Pearson correlation coefficient analysis, which determined the relationship between the sense of involvement and pain level.

Results. The difference in visual analog scale scores between the two groups before the dressing change was not statistically significant ($t = 0{\cdot}196$, $p > 0{\cdot}05$), but the scores became statistically significant after the dressing change ($t = -30{\cdot}792$, $p < 0{\cdot}01$). The correlation between the sense of involvement in a virtual environment and pain level during the dressing was statistically significant ($R^2 = 0{\cdot}5538$, $p < 0{\cdot}05$).

Conclusion. Virtual reality distraction can effectively alleviate pain among patients with a hand injury undergoing a dressing change. Better results can be obtained by increasing the sense of involvement in a virtual environment.

Relevance to clinical practice. Virtual reality distraction can effectively relieve pain without side effects and is not reliant on a doctor's prescription. This tool is convenient for nurses to use, especially when analgesics are unavailable.

What does this paper contribute to the wider global clinical community?

- Virtual reality distraction can effectively alleviate pain among patients with a hand injury undergoing a dressing change.
- Virtual reality distraction can effectively relieve pain without side effects and is not reliant on a doctor's prescriptions. This tool is convenient for nurses to use, especially when analgesics are unavailable.

Key words: adult nursing, dressing change, hand injury, pain, virtual reality

Accepted for publication: 24 March 2014

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Introduction

'Wound-related pain' (WRP) is a term used to describe harmful symptoms or an unpleasant experience directly related to open wounds (Briggs *et al.* 2004). Hand injury is a common cause of trauma surgery, and pain is the primary and most common clinical symptom. After an injury or operation, pain and swelling are unbearable, and dressing removal adds to the pain (Woo & Sibbald 2009). Pain can lead to vascular spasms and affects wound healing, but pain can also benefit skin flap surgery and the survival of replanted amputated fingers. Pain affects wound healing and functional recovery and may even increase the risk of accidents such as syncope and painful shock (Freedman *et al.* 2004). Therefore, using an effective method to reduce hand pain during dressing changes is clinically very important to promote hand wound healing and hand function. Currently, local narcotic dressings or noninvasive dressings are used in developed countries to ease pain (Bell & McCarthy 2010). However, these treatments can cause respiratory depression, decreased blood pressure and other side effects. In China, these treatments can increase the cost of treatment and other unfavourable factors due to economic, technical and other conditions. The World Union of Wound Healing Societies (WUWHS) advocates for reducing or relieving pain by nonpharmacological methods (Briggs *et al.* 2004). Distraction has gained modern scientific validation as a pain control method. Distraction as a nonpharmacological pain control tool has been verified by modern science (Valet *et al.* 2004, Johnson 2005). A study confirmed that pain perception requires attention and participation. Although individual attention is limited (Koshi & Short 2007), the individual can undergo stimulation attention, increase the sense of pleasure to stimulate interest, reduce the transmission of nociceptive signals and reduce pain perception. Therefore, wound treatment staff should be concerned about pain and should take effective measures to relieve pain in patients during the dressing replacement process.

With the development of computer technology, virtual reality (VR) is a new method of distracting patients during invasive procedures to relieve pain and has been applied in the medical field (Wiederhold & Wiederhold 2004). VR is a type of computer system using man–machine interfaces. When users feel that they are in the scene, their attention is effectively removed from pain, and thus, the perception of pain is reduced (Hoffman *et al.* 2000, 2004).

In recent years, VR as a distraction therapy has been widely used in clinical medical care to relieve pain, including in burn patients with debridement, in rehabilitation training for children with cancer and for injection in the treatment of complex regional pain (Nilsson *et al.* 2009, Ramachandran & Seckel 2010, Maani *et al.* 2011). However, these studies were mainly performed abroad, and due to cultural differences in China, the results need to be confirmed in domestic clinical research.

In this study, the effect of VR was investigated in alleviating wound dressing pain. We conducted clinical trials involving 98 patients with hand trauma wound care pain from February–December 2012. The results are presented below.

Background

Virtual reality distraction can effectively alleviate pain among patients undergoing a dressing change. Clinical research has not investigated pain control during a dressing change. The effects are likely to be different from other countries because of culture differences. Therefore, the effects of virtual reality distraction on pain must be explored in China.

Materials and methods

Ethics statement

This study was approved and authorised by the ethics committee of the First College of Clinical Medical Science, China Three Gorges University.

General information

Ninety-eight patients with hand injuries that needed dressing changes were selected from an outpatient surgical treatment facility to participate in the study from February–December 2012. The inclusion criteria included the following: (1) serious hand injuries, including hand skin avulsion, soft tissue defects, damage to the nail bed, fingers, hands etc. caused by crush injuries or firearm injuries, (2) debridement or suturing within 72 hours of injury, (3) age ≥18 years old, male or female, and (4) the ability to complete the scale and volunteer for the research. The exclusion criteria were as follows: (1) used analgesics or required the use of other analgesic interventions within 72 hours after injury, (2) fewer than three dressing changes, and (3) visual acuity <1·0, hearing disorders, cognitive ability (AMT) <8 points. Eighty-five male patients and 13 females aged 18–65 enrolled in the study. In the first dressing change sequence, the 98 patients were randomly divided into an experimental group and a control group. Forty-five males

and four females enrolled in the experimental group. The average age of patients in this group was 30·13 ± 19·54 years; 39 patients had a secondary education or below, and 10 had a college or higher level of education. Wound types were as follows: soft tissue defects (seven patients); cuts (11); skin avulsion (13); and nail bed, finger, or hand damage (18). Forty males and nine females were enrolled in the control group. The average age of patients in this group was 32·05 ± 17·43 years; 41 patients had a secondary education or below, and eight had a college-level education or higher. Wound types were as follows: soft tissue defect (five patients); cuts (10); skin avulsion (14); and nail bed, finger, and hand damage (20). The anxiety levels of the two groups were evaluated before the dressing change using Spielberger's State Trait Anxiety Inventory (STAI) State Anxiety Scale (S-AI) (Shek 1993). All 98 patients completed the study. The differences between the two groups in terms of gender, age, education level, wound type and anxiety level were not statistically significant ($p > 0·05$), indicating that the two groups' anxiety levels were comparable (Table 1).

Intervention methods

The VR devices used in this study were developed by computer professionals, including a pair of ultra-high-resolution 3D glasses, headphones, a mouse and a computer. The 3D glasses and the headphones were output devices, and the mouse was an input device. All of the devices were connected to the computer, which acted as the control system in this VR hardware platform. The 3D film was used as the software platform in this system. The 3D glasses had a full-bracketing Ruanjiao streamline design that covered the entire eye socket and only permitted the image shown on the 3D screen to be seen, and comfort was ensured.

1 Experimental group: Patients were distracted during their dressing change using VR. A trained nurse familiar with VR technology showed patients how to use the VR equipment and assisted patients in wearing the 3D glasses and earphones. In this study, we utilised special audio-visual equipment that uses the realistic 3D film 'Afanda', which depicts a mysterious dream planet Afanda in which users can reach out to touch a graceful scene. Therefore, patients were highly attracted to the film. Patients were asked to watch 3D movies for 5 minutes before the dressing change ended.
2 Control group: Patients did not use the VR equipment. They were asked to close their eyes and accept a conventional dressing repose until dressing was completed.

Evaluation index

In this study, to reduce the bias of the assessment process, the researchers were not directly involved in the assessment and collection of data. One researcher was trained to assist the nurses in assessing and recording the data.

1 Visual analog scale (VAS) (Upton & Andrews 2013): The two patient groups were subjected to three dressing changes. Within 5 minutes of the dressing change, the VAS score was recorded immediately according to the patient's degree of pain. To assist nurses, a digital reading from the scale and rate were recorded three times at two time points and were used to calculate the average values. Pain levels were categorised as follows: mild pain <3, moderate pain three to six, and severe pain >6 points. The scale describes the pain from the patient's perspective and allows the medical staff to better understand the patient. The method allows the staff to accurately grasp the patient's pain and to evaluate pain control during a

Table 1 Demographics and comparison of the two groups

Group	Experimental group (n = 49)	Control group (n = 49)	Statistic	*p*-Value
Gender (male/female)	45/4	40/9	$\chi^2 = 2·217$	0·136
Age (years)	30·13 ± 19·54	32·05 ± 17·43	$t = -0·989$	0·325
Educational level				
Secondary education and below	39	41	$\chi^2 = 0·272$	0·602
College and higher education	10	8		
Wound types				
Soft tissue defect	7	5	$\chi^2 = 0·523$	0·914
Cuts	11	10		
Skin avulsion	13	14		
Nail bed, finger, and hand damage	18	20		
Anxiety levels (score)	39·67 ± 9·25	40·29 ± 10·27	$t = -0·457$	0·648

dressing change. If a patient's pain intensity is five but decreases to three with an intervention, then the intervention measures are effective.

2 Commitment questionnaire: This questionnaire was the Chinese version of a commitment questionnaire based on the questionnaire of Singer and Witer from Hong Kong Polytech University (Chan *et al.* 2007). The questionnaire included 19 items, with two points for each entry. Each item evaluates the seven scores. The total score ranges from 19–133. The higher the score, the stronger the sense of user input. Cronbach's α coefficient of the questionnaire was 0·88. The ability of VR to relieve pain in the experimental group was measured by the degree of user input.

Statistical analysis

Statistical analysis was performed using SPSS 19.0 software (SPSS Inc., IBM, Chicago, IL, USA). Count data were compared with the χ^2 test, and the measurement data are expressed as means ± standard deviation ($\bar{x} \pm s$). Groups were compared using the *t*-test for independent samples. The paired *t*-test was used to compare the groups. The relationship between the sense of involvement and pain level was evaluated using Pearson coefficient analysis, with $p < 0{\cdot}05$ indicating statistical significance.

Results

Comparison of pain level between the groups

The average VAS score before the dressing was 6·52 ± 2·17 in the experimental group and 6·49 ± 3·12 in the control group. The average VAS score at the end of the dressing was 2·63 ± 1·27 in the experimental group and 7·64 ± 3·41 in the control group. The difference was not statistically significant (t = 0·196, 0·845). The VAS score at the end of the dressing change was significantly lower in the experimental group than in the control group, and the difference was statistically significant (t = −30·792, 0·000). In the paired *t*-test, the experimental group showed significantly lower pain scores before the dressing, and the difference was statistically significant (t = 18·311, 0·000). The control group showed a higher pain score before the dressing, and the difference was statistically significant (t = −0·539, 0·000) (Table 2).

Based on the Pearson correlation coefficient test, the differences between the groups' dressing changes and pain levels were statistically significant (R^2 = 0·5538, $p < 0{\cdot}05$, Fig. 1).

Table 2 Comparison of pain scores between the two groups before and after dressing ($\bar{x} \pm s$)

Group	*n*	Before dressing	After dressing	*t*	*p*
The experimental group	49	6·52 ± 2·17	2·63 ± 1·27	18·311	0·000
The control group	49	6·49 ± 3·12	7·64 ± 3·41	−0·539	0·000
t		0·196	−30·792		
p		0·845	0·000		

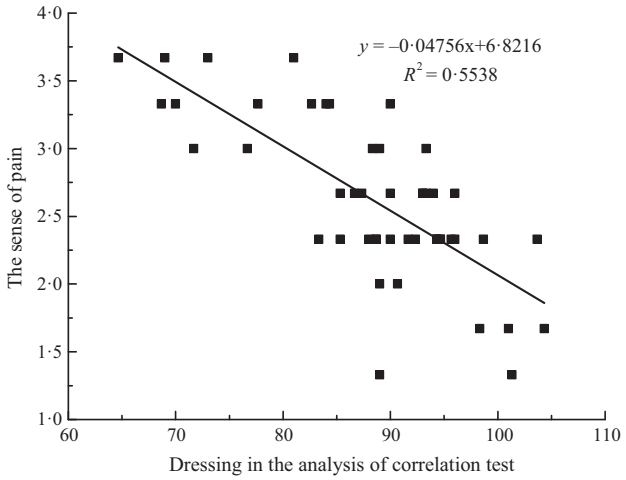

Figure 1 The relationship between pain level and the dressing change in patients.

Discussion

The results of this study indicate that the experimental group's pain score before the dressing change was significantly lower than the control group, indicating that VR distraction can effectively reduce hand wound pain during dressing changes. Studies have shown that people can only focus on one thing at a time, and diverting attention from the pain towards a more interesting task can block the link between the stimulus and the conditioned response, so people do not feel pain or they experience pain relief (Johnson 2005). In this study, the experimental group was placed in a virtual environment to divert their attention from the dressing process by using a 3D film, and less attention to the dressing change alleviated the pain. At the end of the dressing, the control group's pain score increased, consistent with previous studies (Woo & Sibbald 2009). In the present study, the sense of involvement questionnaire was used to measure the experimental group's sense of engagement in the virtual environment and to assess the role played by VR in relieving pain. The results show that in the

experimental group, the patients' commitment had a significant correlation with pain. The more the patients perceived pain, the smaller the perceived pain response. Commitment is a psychological state of the consciousness of an individual. An individual can perceive himself in many virtual environments, and VR as an evaluation of individual attention is an important tool. The results revealed that VR highly attracted patients to the virtual environment to increase the effect of pain control, which is consistent with the results of some scholars: when attention is increasingly focused on other activities, pain is more effectively reduced.

As previously indicated, applying realistic 3D film could relieve cancer pain (Koshi & Short 2007). The VR system employed in this study transmitted the visual and auditory senses through the 3D glasses and headphones that made the patients enter into the virtual environment and have a sense of presence produced by the virtual reality system. This method attracted the patient's attention and increased commitment, by which the pain was relieved.

Research assessing VR in pain relief plays a role only in patients with a subjective assessment of pain. Differences in individual cognition may lead to a deviation in the results. If objective indicators such as the patient's pulse, blood pressure and immersion are used, the results may be more persuasive.

Conclusion

Virtual reality distraction can effectively alleviate pain among patients with a hand injury undergoing a dressing change. Better pain relief can be obtained by increasing the sense of involvement in the virtual environment.

Relevance to clinical practice

Compared with conventional trials, patients with traumatic wounds in the present study were strongly connected with clinical practice. Virtual reality distraction can effectively relieve pain without side effects and is not reliant on a doctor's prescription. It is convenient for nurses to use, especially when analgesics are unavailable.

Acknowledgements

This project was supported by the National Natural Science Foundation of China (Grant No. 81200088) and the Natural Science Foundation of Yichang city, China (Grant No. A12301-01).

Disclosure

The authors have confirmed that all authors meet the ICMJE criteria for authorship credit (www.icmje.org/ethical_1author.html), as follows: (1) substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, and (3) final approval of the version to be published.

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