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# Effect of Virtual Reality on Relieving Pain and Anxiety of Circumcision in Children

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**Abstract**

**Background:** Circumcision is a common surgery and causes severe pain and anxiety in children. Today, virtual reality is used as an easy and cost-effective non-pharmacological method to manage pain and anxiety with no side effects.

**Aim:** This study aimed to investigate the effect of virtual reality on the reduction of pain and anxiety in children who underwent circumcision.

**Method:** This single-blind randomized clinical trial was performed on 40 children in 2019. The research instruments included the demographic survey, the Observational Scale of Behavioral Distress, and the Oucher pain scale which were completed in both groups 30 min before and after the circumcision (immediately after dressing the surgical wound). Anxiety immediately before circumcision. The children's pain was assessed during anesthesia in both groups. A two-step intervention was performed on the experimental group. A preoperative virtual reality training video and a virtual reality animation were presented to distract the patients during the circumcision. All these steps except virtual reality were performed in the control group. Data were analyzed using SPSS software (version 16).

**Results:** Virtual reality as a distraction technique significantly reduced anxiety and pain at the onset of circumcision ($P<0.001$) and during anesthesia ($P<0.001$) as well as pain ($P=0.005$) and anxiety ($P<0.001$) at the end of the circumcision in the intervention group compared to the control group.

**Implications for Practice:** Clinical use of virtual reality can be used for the reduction of pain and anxiety in children during the circumcision process.

**Keywords:** Anxiety, Child, Circumcision, Male, Pain, Virtual reality

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## Introduction

Circumcision is one of the most common surgeries in the world and causes great pain and anxiety in children (1) which in turn leads to child's dissatisfaction, slow recovery, irregular sleep and nutrition patterns, and lack of cooperation. Therefore, action should be taken to relieve pain and anxiety in children and prevent poor health care (2).

Pain and anxiety management requires pharmacological and non-pharmacological methods (3-4). Various studies have suggested non-pharmacological interventions, such as distraction, hypnosis, and cognitive-behavioral therapy to manage pain and anxiety in children (5). Non-pharmacological interventions are simple and effective, require no special timing or expensive equipment, and have no side effects (4).

Non-pharmacological methods easily increase adaptability and reduce anxiety and are also accompanied by easy acceptance and good cooperation from the children and their parents (6).

Virtual reality is a new, easy, and affordable technology (5) in which the user feels the physical presence in the virtual world and can interact constructively with the environment (7).

Comprehensive interaction with virtual reality causes distraction and slower reaction to pain signals (8). It has been also used to manage pain and distress in a wide range of painful medical procedures, such as bleeding, wound care, burn care, chemotherapy, dental treatments, and immunizations (9). Research also showed that much attention has been paid to the effect of virtual reality on mental disorders, such as pain, stress, fear and common anxiety (7). However, some studies suggests that multimedia education is more effective than virtual reality (10).

The high prevalence of circumcision in children and the fact that it may be the child's first referral to the health care system is indicative of the undeniable importance of the following procedure. Although the child is conscious during circumcision, the process is unclear to him, which doubles his pain and anxiety. Circumcision is important since it affects a person's body image. The literature review indicated that studies in this field are more focused on circumcision methods, ethical implications, and pharmacological control of pain, prevalence, and complications of circumcision. It should be noted that the function of virtual reality in the distraction of pain or anxiety has received more attention than its educational dimension in the previous studies. The present study, to the best of our knowledge, is the first to simultaneously investigates the educational and pain distracting aspects of virtual reality on managing children's pain and anxiety. In addition, the duration of circumcision procedure is longer than other invasive procedures and is unfamiliar to the child. Therefore, it was decided to investigate the effectiveness of virtual reality on controlling pain and anxiety in children aged 5-10 years due to its effect on reducing complications and postoperative recovery time, low cost, safety and attractiveness for children compared to non-pharmacological methods.

## Methods

The present study was a single-blind randomized clinical trial in which blinding was performed on research samples. The study was conducted on children aged 5-10 years who were referred to the urology clinic for circumcision in Gonabad, Iran in 2019.

The sample size was obtained at 18 for each group based on the data of a similar study (11) using the formula for comparing means in two independent samples for pain variable and considering the confidence coefficient of 95% and test power of 90%. Eventually, 20 participants were placed in each group considering 10% attrition rate.

The children were divided into two groups of intervention and control through permuted block randomization approach. A total of six possible states (BABA, ABBA, BAAB, AABB, ABAB, BBAA) were listed. The required number of blocks was accidentally determined and the individuals were placed in the intervention (virtual reality) (A) and control (B) groups, respectively.

Inclusion criteria included 1) age range of 5-10, 2) no history of personality anxiety, 3) no history of surgery, 4) hearing or vision impairment, 5) coagulation problems, and 6) hypospadias or epispadias. Exclusion criteria included the unwillingness of the child or parents to continue participating in the study, severe anxiety, and abnormal bleeding during the operation. The conditions in both groups were the same in terms of the surgeon, the operating room, and the presence of the parents. In addition, the necessary information about the project was provided to the participants and written informed consent was obtained from the parents before participating in

the study.

The data were collected using a demographic survey, Observational Scale of Behavioral Distress-Revised (OSBD-R), and the Oucher pain scale. The researcher completed the demographic characteristic form which included questions about parents' age, education level, occupation, child's age, birth order, history of surgery and hospitalization, the dose of applied lidocaine, and duration of surgery. This questionnaire was prepared after studying the sources related to the topic of the study. In addition, the necessary revisions were made based on the experts' points of view.

Oucher pain scale is a self-report scale for measuring the severity of pain in children based on their facial expressions, scored from 1 to 6 from the lowest to the highest degree of pain ( 1= no pain to 6= severe pain). The validity and reliability of this scale have been confirmed in previous studies (12-14). Mahdipour et al. calculated the Pearson correlation coefficient for this scale (r= 0.92) (15).

The OSBD-R is a popular standard scale for determining anxiety and has proper validity and reliability (16). The scales is scored from 0 to 4. Moreover, 0.5 and 0 are given to any behavior observed, or the lack of behavior, respectively. This scale measures eight behaviors including crying, screaming, restraint, verbal resistance, information-seeking, solicitation of emotional support, verbal pain expression, and flexibility. The total score of 1 or less is considered the lack of anxiety, 1.5- 2= mild anxiety, 2.5- 3= moderate anxiety, and 3.5- 4= severe anxiety. This tool has been used in various studies. Ebrahimpour et al. investigated the reliability of OSBD-R using test-retest method (r=0.79) and Cronbach's alpha (r=0.85) (17).

The intervention was performed in two stages for the experimental group. A virtual reality training video and a virtual reality animation were presented to distract the children before and during the circumcision, while the control group received no intervention. The demographic characteristics form, Oucher pain scale, and OSBD-R were completed by both groups 30 min before the operation. Afterward, an instructional video was displayed about the operation environment, the pleasant experiences, and postoperative recommendations in the language of the circumcised child to the intervention group using a virtual reality headset (Remax-RT-V03 audio-visual glasses with internal memory based on Android). This video took 4 min and 35 sec and aimed to increase the awareness of other children toward circumcision surgery. The content of the presented virtual reality tutorial video and animation was approved by the relevant expert.

The level of anxiety was re-measured in both intervention and control groups when the children were laid on the operating table before surgery. Again, a 360-degree full HD animation (Tom and Jerry series) was played for the intervention group using a virtual reality headset from the beginning to the end of the circumcision procedure (approximately 20 min).

Lidocaine was injected as soon as the animation was displayed and the child's pain was measured using the Oucher pain scale simultaneously in both groups. Circumcision was performed by the same urologist using a forceps-guided method for approximately 20 min. At the end of the operation, child's pain and anxiety were assessed in both groups immediately after he was dressed. It should be noted that the questionnaires were completed in both groups with help of a trained assistant under the supervision of the researcher. All these steps, except for virtual reality part, were performed in the control group (Figure 1). In addition, the injection was performed in both groups using a 27-gauge needle and a 5.5 ml dose of lidocaine.

Data were analyzed using SPSS software (Version 16). The normality of the quantitative variables was investigated through the Kolmogorov-Smirnov test.

The independent t-test and the Mann-Whitney U test were implemented to compare quantitative variables in both groups. Friedman test was also used to compare quantitative variables over three consecutive times. All statistical tests were performed in two domains at a significance level of 0.05.

**Results**

The mean±SD age of children in the control and the intervention groups was estimated at 6.35±1.22 and 7.03±1.38, respectively (P=0.11). The demographic characteristics of the two groups and the pain and anxiety 30 min before surgery are compared in Table 1.

The mentioned pain is compared in both groups in three stages: 30 min before circumcision, at the moment of anesthesia injection, and at the end of circumcision procedure (Table 2). The pain was significantly increased at the time of anesthesia injection (P<0.001) and the end of circumcision

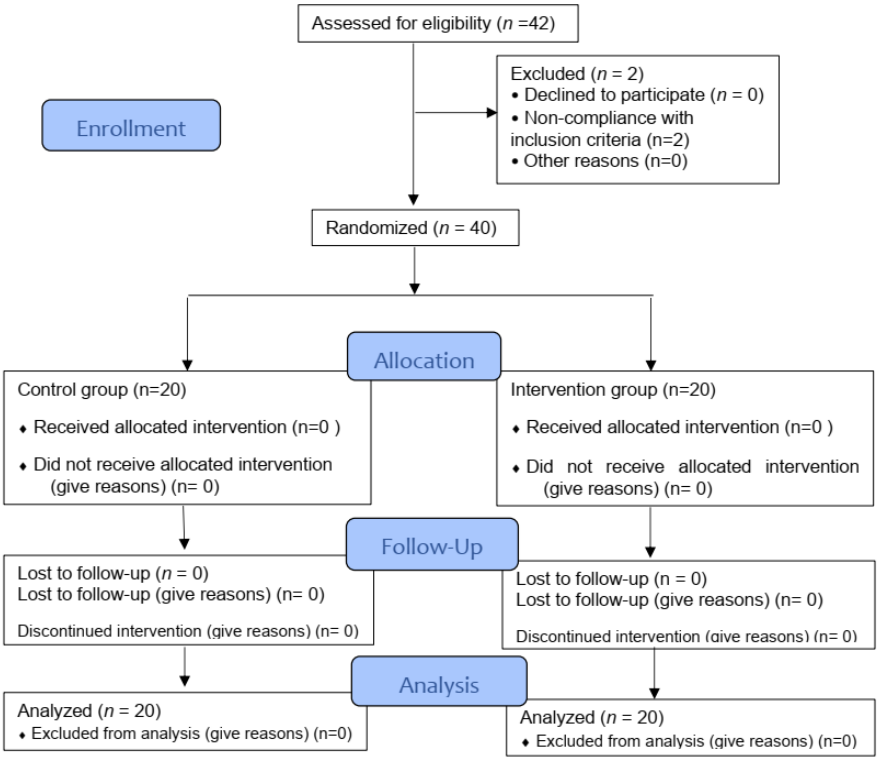


**Figure 1. CONSORT flowchart of study representation**

**Table 1. Comparison of the demographic characteristics of the two groups**

| Variable | | Control group Number (percent) | Test group Number (percent) | Test result |
|---|---|---|---|---|
| Mather's education level | Middle school and less | 6(30) | 6(30) | 0.51* |
| | High school and diploma | 5(25) | 8(40) | |
| | Associate's and Bachelor's degree | 7(35) | 5(25) | |
| | Master's degree and above | 2(10) | 1(5) | |
| Father's education level | Middle school and less | 4(20) | 6(30) | 0.23* |
| | High school and diploma | 9(45) | 10(50) | |
| | Associate's degree and Bachelor's degree | 10(25) | 4(20) | |
| | Master's degree and above | 2(10) | 0(0) | |
| Mother's occupation | Housewife | 13(65) | 16(80) | 0.28*** |
| | Employed | 7(35) | 4(20) | |
| Father's occupation | Self-employed | 14(70) | 17(85) | 0.45**** |
| | Employee | 6(30) | 3(15) | |
| History of hospitalization | Yes | 6(30) | 6(30) | P > 0.99*** |
| | No | 14(70) | 14(70) | |
| Variable | | Mean±Standard deviation | Mean±Standard deviation | Test result |
| Age | | 1.22± 6.35 | 7.03±1.38 | *****P=0.11 |
| Mother's age | | 33.55±5.44 | 35.33±4.39 | **P=0.58 |
| Father's age | | 28.65±5.80 | 38.85±5.24 | *****P=0.91 |
| Child's birth order | | 2±0.85 | 1.95±0.82 | **P=0.92 |
| Duration of circumcision | | 20.05±1.14 | 20.10±1.37 | **P=0.90 |
| Dose of lidocaine | | 5.50±0.82 | 5.45±0.68 | **P=0.98 |
| Pain before circumcision | | 1.10±0.30 | 1.10±0.30 | **P=1.00 |
| Anxiety before circumcision | | 0.30±0.65 | 0.05±0.224 | **P=0.144 |

* Kruskal-Wallis ** Mann–Whitney U test *** Chi-Square
**** Fisher's Exact test *****Independent samples t-test

**Table 2. Comparison of pain in the two groups 30 min before circumcision, at the moment of anesthesia injection, and at the end of circumcision**

| Variable | Group | 30 minutes before surgery mean±Standard deviation | Moment of injection mean±Standard deviation | The end of circumcision mean±Standard deviation | Result of repeated measure test | | |
|---|---|---|---|---|---|---|---|
| | | | | | Time effect | Group effect | Time* group effect |
| Pain | Test | 1.10±0.30 | 2.5±1.14 | 1.10±0.30 | *<0.001 | *<0.001 | 0.10 |
| | Control | 1.10±0.30 | 3.60±0.99 | 2.30±0.65 | | | |
| Between group comparison based on time point | | >0.99** | **<0.001 | **0.005 | | | |

* Repeated-measure test
** Mann–Whitney U test

(P=0.005) in the control group compared to the intervention group. Repeated measure ANOVA test showed a significant difference in the mean total score of pain between the two groups (P<0.001). Moreover, there was a significant difference in the three-time intervals (P<0.001). The results of Post Hoc test (LSD) showed a significant difference in terms of pain score among all three intervals (P<0.001). The interaction effect of group and time was not significant (P=0.10).

Levels of Anxiety in two groups were compared 30 min before circumcision, at the beginning and at the end of circumcision (Table 3). The anxiety of the control group at the beginning of circumcision (P<0.001) and at the end of circumcision (P<0.001) was significantly higher than those of the intervention group. Repeated measure ANOVA indicated a significant difference in the mean total score of anxiety between the two groups (P<0.001). Also, there was a significant difference at three-time intervals (P<0.001). The Post Hoc test (LSD) demonstrated a significant difference between all three intervals (P<0.001). The interaction effect of group and time was also significant (P= 0.03).

**Table 3. Comparison of anxiety in the two groups 30 minutes before circumcision, at the beginning and at the end of circumcision**

| Variable | Group | 30 minutes before surgery mean±Standard deviation | Moment of injection mean±Standard deviation | The end of circumcision mean±Standard deviation | Result of repeated measure test | | |
|---|---|---|---|---|---|---|---|
| | | | | | Time effect | Group effect | Time* group effect |
| Anxiety | Test | 0.05±0.22 | 1.35±0.87 | 0.15±0.36 | *<0.001 | *<0.001 | 0.03 |
| | Control | 0.30±0.65 | 2.65±1.04 | 1.70±0.73 | | | |
| Between group comparison based on time point | | **0.144 | **<0.001 | **<0.001 | | | |

* Repeated-measure test
** Mann–Whitney U test

## Discussion

Based on the obtained results, the application of virtual reality for the distraction of the children significantly reduced their anxiety and pain at the beginning of circumcision and at the moment of anesthesia injection in the experimental group compared to controls.

In line with the results of the present study, Chan et al. (2019) stated that the use of virtual reality significantly reduces the pain of needles in children (18). Mikaeli et al. (2019) concluded that watching cartoons and making bubbles reduced pain in children during chemotherapy (6). The results of a review study conducted by Zaka in 2015 showed that pre-operative exercise training, based on the age and cultural background can reduce the anxiety of children and their parents before and after surgery and that pre-operative training animation is one of the most effective ways to manage anxiety in children (19).

The increase of preoperative awareness is an effective way to reduce anxiety, stress, and pain in patients and leads to greater satisfaction and progress in the recovery process (20). The development of training animation according to the type of procedure and necessary postoperative care is both effective and interesting for children (19). It also decreases anxiety in children which in turn leads to

the reduction of parents' anxiety.

In this study, the intervention group, who were distracted by virtual reality at the time of injection, felt less pain compared to the control group. Babaei et al. (2015) concluded that distraction through cyberspace alleviates children's pain, fear, and anxiety, and practically reduces their resilience (21).

In the same line, Chen et al. (2020) reported that the application of virtual reality for distraction significantly reduced pain during intravenous injection in the intervention group (22). In the present study, anxiety at the onset of circumcision was significantly increased in both groups compared to 30 min before the surgery, which may be due to the child lying on the bed or the pain of injecting lidocaine.

The results of the present study were consistent with those of Ghardashi et al. (2004) indicating that the patients experienced more anxiety on the morning of surgery day (immediately before entering the operating room) than in the evening of the day before surgery (23). This seems to be normal considering the approaching time of surgery. Comparison of anxiety and pain at the end of circumcision indicated a statistically significant difference between the two groups. At the end of the circumcision, the mean±SD anxiety score in the control and intervention groups was measured at 1.70±0.73 and 0.15±0.36, respectively.

The mean±SD pain score was also reported to be 2.30±0.65 and 1.10±0.30 in the control and experimental groups, respectively.

According to the study performed by Wiederhold et al. (2014), the use of virtual reality could reduce the pain and anxiety caused by dental procedures to the moderate and mild (24). Debashish et al. (2005) reported that the average pain score was obtained at 4.1 during changing children's dressings when he was receiving painkillers, and at 1.3 at simultaneous use of virtual reality games (25).

Ganry et al. (2018) proved that the display of nature images through virtual reality for 5 min significantly decreased anxiety in adult patients who were candidates for outpatient surgery (26).

Hesabi et al. (2018) showed that the use of relaxing images based on virtual reality reduced the anxiety of hospitalized patients in the cardiac intensive care unit (27). Eijlers et al. in a meta-analysis review in 2019 reported that virtual reality is an effective distraction intervention to diminish pain and anxiety before and during treatment (2).

Arane et al. (2017) suggested that the applicaton of virtual reality alone or in combination with standard therapies reduced pain and anxiety in children more than other distraction techniques (8).

Ghahramanpour et al. (2017) compared the effect of multimedia and virtual reality on the control of pain and anxiety in adult burn patients. The difference in results of the two studies may be due to discrepancies in the application of virtual reality. The study performed by Ghahramanpour compared two mediat in terms of their potential for creating distraction, while the present study focused on the application of virtual reality for the pupose of education and distraction. In addition, virtual reality seems to be more attractive to children than adults due to the differences in the study population (10).

It is worth mentioning that Setoodeh et al. (2013) declared that educational psychological interventions had no effect on post-tonsillectomy pain in children aged 9 to 12 years; however, it helped them to resume their normal activities more quickly. It seems that the performance of intervention in form of short question and answer session, interview, video presentation, and the educational booklet was not enough to change the child's perception of pain. Factors affecting the results of the study included the completion of the questionnaire by mother and exaggeration of the pain by the child in order to attract the attention of the family (28).

In the present study, preoperative virtual reality training video increased the awareness and psychological readiness of children regarding the circumcision surgery. This reduced the stress and cooperation of children, as well as the satisfaction of their parents. This may be due to the visual and auditory nature of this technology and simulation, through which the patient tries to communicate with the environment due to its unrealistic nature to overcome the limitations of the real world (7).

Children correct their misconceptions and negative attitudes and realize that they are not at risk after they become familiar with the operating environment and the circumcision procedure by a peer child. This reduces their stress level which then leads to more cooperation from the child's side. The virtual reality animation is very appealing to children and reduces the pain of anesthesia injections and the stress of circumcision by distracting the child from the pain. Distraction with 3D virtual space glasses is as effective as or more effective than medication (21).

It is recommended to use virtual reality as an effective non-pharmacological intervention to relieve

pain and anxiety in children alone or along with other pain and anxiety management techniques. Eventually, the small sample size can be considered a limitation in this study.

**Implications for Practice**

The results of the present study indicated the effect of virtual reality in reducing pain and anxiety caused by circumcision in children. This intervention can be used in various fields of nursing, including clinical services and training to nurses working in surgical and pediatric wards. It is recommended to use the results of this study to improve the quality of nursing, pain and anxiety management, quick impact, elimination of drug side effects, and independence of health care providers in the application of this method for the enhancement of the physical and mental health of children.

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**Conflicts of Interest**

The authors declare that there is no conflict of interests regarding the publication of the present study.

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