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Effect of audiovisual eyeglasses during dental treatment in 5–8 year-old children

ABSTRACT

Aim To evaluate the effect of Audiovisual (AV) eyeglasses on pain and anxiety levels during restorative treatment in 5–8 year-olds Thai children.

Materials and methods Study design: Forty-two children with bilateral carious molars were recruited and randomly divided into 2 groups according to the sequence of AV eyeglasses used. Group I was a group which received treatment without wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit. Group II was vice versa. Treatments were done in 2 visits, 1 to 4 weeks apart. Self-reporting pain using the Faces Pain Scale-Revised (FPS-R), face, legs, activity, crying and consolability scale (FLACC) and heart rate (HR), were measured to assess pain and anxiety levels, respectively. Besides baseline, all variables were measured at the following periods: 1) pre-operation, 2) rubber dam placement, 3) the first use of high speed hand piece, and 4) five minutes interval during the remaining treatment.

Results There was no significant difference in gender ($p=0.204$) and treatment arch ($p=0.292$) using Chi-square test at $p<0.05$, previous dental experience ($p=0.381$) and treatment received ($p=0.835$) using Fisher's exact test at $p<0.05$, age ($p=0.384$, T-test at $p<0.05$), and treatment time (1st visit: $p=0.465$, 2nd visit: $p=0.89$, Mann-Whitney U test at $p<0.05$) between 2 groups. AV eyeglasses effectively reduced HR in pre-operation ($p=0.043$, T test at $p<0.05$) and FLACC scores in pre-operation ($p=0.018$, Mann-

Whitney U test at $p<0.05$) and during the first use of high speed hand piece ($p=0.047$, Mann-Whitney U test at $p<0.05$). However, HR were decreased during rubber dam placement ($p=0.002$, T test at $p<0.0$), the first use of high speed hand piece ($p=0.049$, T test at $p<0.05$) and during remaining treatment ($p=0.035$, T test at $p<0.05$) in second visit as compared with the first visit with or without wearing the eyeglasses.

Conclusion AV eyeglasses successfully reduced HR and physical distress during pre-operation and the first use of high speed hand piece. It could be used as an adjunctive distraction technique during dental treatment in children.

Keywords Anxiety; Audiovisual eyeglasses; Dental treatment in children; Distraction technique; Pain.

Introduction

The prevalence of dental fear and anxiety in child patients varied from 6–20% in different populations [Klingberg and Broberg, 2007]. One fifth of the adult population suffers from dental anxiety and half of them reported that they had developed a fear of dental treatment during their childhood [Locker et al., 1999]. Many studies showed that the development of dental fear and anxiety in children is strongly associated with an exposure to a negative dental experience resulting from painful dental procedures [Locker et al., 1999; Townend et al., 2000; Versloota et al., 2008].

Numerous studies show that the anxious child has higher caries rates and often deferred or cancelled appointments [Hoge et al., 2012; Wogelius et al., 2003; Klingberg et al., 1995]. Fearful children often present with behaviour problems in the dental clinic. Distraction technique is a non-aversive behaviour management procedure which is widely used because it is simple, safe, and inexpensive and effectively reduces distress and disruptive behaviour in child patients during the invasive medical procedures [Peretz et al., 1999]. These techniques aim to engage child's attention away from unpleasant stimuli, which help in managing their procedural anxiety, distress, and pain. Conventional distraction techniques have been investigated in different medical and dental settings. These techniques include breath counting, listening to music or stories, watching videos or otherwise engaging the patient's attention away from discomforting procedures [Peretz et al., 1999; Aitken et al., 2002; Frere et al., 2001; Wang et al., 2008; Cassidy et al., 2002 Venham et al., 1981; Downey et al., 2012]. A few studies have examined the efficacy of audiovisual distraction on reducing child's distress during medical and dental procedures such as venipuncture,

immunisation, and during dental treatments [Wang et al., 2008; Cassidy et al., 2002; Venham et al., 1981; Downey et al., 2012; Ram et al., 2010; Sullivan et al., 2000]. However, results are varied. This might be from using different distraction method such as TV and music. Previous study suggested that the efficacy of watching a big screen TV or listening to music during dental treatment was not highly effective enough in reducing pain and anxiety because child's attention was not fully focused on TV and was sporadically distracted by the surrounding environment [Ram et al., 2010]. Thus, child's attention often returned to the continuing dental procedure especially any threatening one.

There are a few studies investigating the efficacy of audiovisual eyeglasses (AV eyeglasses) in pain reduction in children during dental treatment. El-Sharkawi and colleagues found that AV eyeglasses effectively reduced pain during the local anaesthetic injections [El-Sharkawi et al., 2012]. Ram and colleagues reported that AV eyeglasses were a successful distraction technique during dental treatment in children [Ram et al., 2010]. Frere and colleagues reported that AV eyeglasses successfully reduced pain level and heart rate and shortened treatment time in most of adult subjects during prophylaxis and scaling visit [Frere et al., 2001]. To the best of our knowledge, a limited number of studies have demonstrated the efficacy of AV eyeglasses in reducing pain and anxiety during dental treatment in children.

The objective of this study was to evaluate the efficacy of AV eyeglasses in reducing pain and anxiety levels in 5-8 years old children during restorative dental treatment. Anxiety level was assessed by measuring heart rate (HR) and physical distress using face, legs, activity, crying and consolability scale (FLACC). Pain level was assessed using self-reporting pain scale (Faces Pain Scale-Revised - FPS-R). Besides baseline, all variables were measured at the following periods: 1) pre-operation, 2) rubber dam placement, 3) the first use of high speed hand piece, and 4) five minutes interval during the remaining treatment. The proposed hypothesis was that anxiety and pain levels in all periods measured during the restorative treatment when wearing AV eyeglasses would be lower for most children.

Materials and methods

This study was approved by the Ethical Human Research Committee, Mahidol University (MU-IRB 2013.112/1709), the director of the Golden Jubilee Medical Center, Salaya campus, Nakornpathom province and the director of Nong Don Community Hospital, Saraburi province, Thailand. Consents were received from all parents/legal guardians. All subjects were free to withdraw from the study at any time without affecting their dental treatment. Statistician consultation was done before sample size

was calculated based on the McNemar test using nQuery Advisor program. With type I error=5%, Type II error = 20%, power=85%, the minimum participant number was 43 is enough for statistic achievement [El-Sharkawi et al., 2012]. Total subjects would be 52 to make up for any possible lost cases (20%).

Subject selection

Subjects were conveniently selected based on their need for restorative dental treatments from patients who came to the paediatric dental clinic, the Golden Jubilee Medical Center, Salaya campus, Nakornpathom province and dental clinic, Nong Don Community Hospital, Saraburi province, Thailand. Restorative procedures included amalgam and composite fillings, stainless steel crowns, pulpotomy, pulpectomy and extraction. All subjects were healthy (ASA 1) children aged between 5-8 years old, had bilateral carious molars on either maxilla or mandible which required restorative dental treatment under local anaesthetic injection and were not emergency treatments. Frankl scale was used during the recruitment visit. It is one of the more reliable and frequently used behaviour rating systems in both clinical dentistry and research [AAPD, 2013-14]. This scale separates observed behaviours into four categories ranging from definitely negative to definitely positive (Rating 1: Definitely negative; Refusal of treatment; crying forcefully, fearful, or any other evidence of extreme negativism, rating 2: Negative; Reluctance to accept treatment; uncooperative; some evidence of negative attitude but not pronounced, i.e., sudden withdrawal, rating 3: Acceptance of treatment: at times cautious: willingness to comply with the dentist, at times with reservation, but patient follows the dentist's directions cooperatively, rating 4: Definitely positive; Good rapport with dentist; interested in the dental procedures; laughing and enjoying the situation). Selected subjects were rated a positive behaviour (Frankl scale 3 or 4) patient during a previous examination, radiographic examination, prophylaxis procedures and anaesthetic injection (if previously had dental treatment under the local anaesthesia injection) and were willing to wear AV eyeglasses for the entire procedure.

AV eyeglasses are a device composed of a head-mounted display and in-ear headphones which provide close proximity device aimed at reducing visual and auditory interferences from the environment. AV eyeglasses used in this study were the video glasses cool vision 3 (Shenzhen Longway Vision Technology Co. Ltd, Shenzhen, China). The head-mounted virtual screen is 72 inch 4:3 wide weighing 95 g. The device can be adjusted for focus and interpupillary distance. It has two-channel stereo surround support from a pair of in-ear headphones. The external memory with micro SD card support is up to 32 GB. A USB connection cable can transfer video to the memory, and the device has a 3.5 hours duration rechargeable battery (Fig. 1A).

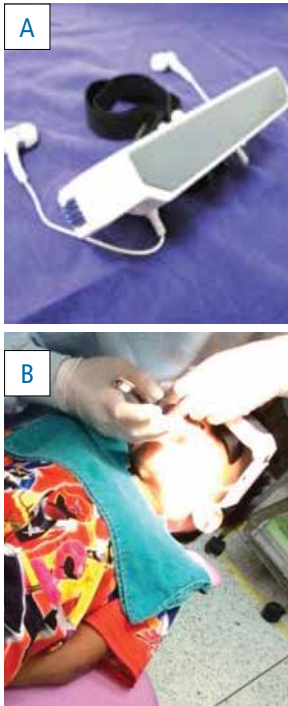


FIG. 1 A: Audiovisual eyeglasses used during restorative dental treatment was video glasses cool vision 3 (Shenzhen Longway Vision Technology Co.Ltd, Shenzhen, China). Head-mounted virtual screen is a 72 inch 4:3 wide screen weigh 95 g. The device can be adjusted for focus and interpupillary distance. It has two-channel stereo surround support from a pair of in-ear headphones. The external memory with micro SD card support is up to 32 GB. A USB connection cable can transfer video to the memory, and the device has a rechargeable battery with 3.5 hours duration. **B:** A child receiving dental treatment while wearing the AV eyeglasses.

Study design

This was a split-mouth cross-over randomised control trial. Subjects were randomly divided into 2 groups according to the sequence of AV eyeglasses used (Fig. 1B). Group I was a group which received dental treatment without wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit. Group II was a group that received the dental treatment wearing AV eyeglasses in the first visit and without wearing the eyeglasses in a second visit. Treatments were done in 2 visits, 1 to 4 weeks apart (Fig. 2). Two paediatric dental residents performed all dental treatments following standard protocol. Each subject was treated by the same dentist for both visits. All parents were absent in the operating area. During dental treatment, dentists explained about the procedure in lay terms using tell-show-do technique including the presence of a blood pressure cuff for measuring HR. For another visit, the one wearing AV eyeglasses, an introduction to the eyeglasses with a choice of five cartoon movies (adventure/superhero and princess stories) was presented to subjects. They were given a few minutes to get accustomed to the eyeglasses. For another visit that was not wearing the eyeglasses, other behaviour management techniques which were tell-show-do, positive reinforcement and conventional distraction (deep breath or breath counting) was used.

Assessment of pain and anxiety level

All variables were measured at the following periods:
 1) pre-operation;
 2) rubber dam placement;

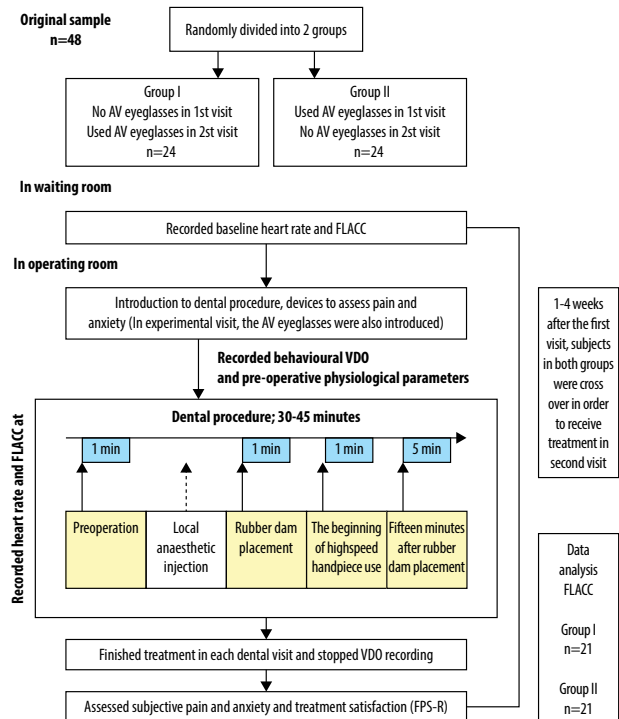


FIG. 2 Diagram showed that there were 48 original participants (n=24 in each group). At the end of the study, 6 children were excluded. One of them failed to return for a second visit. Four were not able to rate their behaviours due to VDO mechanical problems and the other participant refused to wear AV eyeglasses at the second visit. At the end of the study, 42 participants remained.

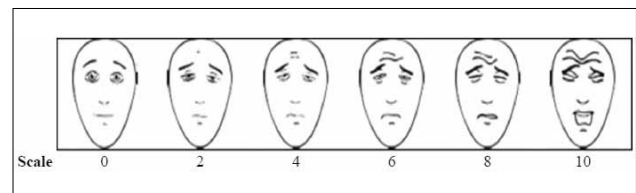


FIG. 3 The Faces Pain Scale–Revised (FPS-R) scored 0, 2, 4, 6, 8, and 10. It was modified from the Faces Pain Scale in order to make it possible to score on the widely accepted 0 to 10 metric scale. It shows a close linear relationship with visual analogue pain scales across the age range of 4 to 16 years. It is easy to administer and requires no equipment except for the photocopied faces. Score the chosen face 0, 2, 4, 6, 8, or 10, counting left to right, so '0' = 'no pain' and '10' = 'very much pain.' Do not use words like 'happy' and 'sad.' This scale is intended to measure how children feel, not how their face looks.

- 3) the first use of high speed hand piece;
- 4) five minutes interval during the remaining treatment.

Child pain rating scale

Self-reported pain using the Faces Pain Scale-Revised (FPS-R) scale was assessed treatment pain in 4 periods during the treatment. FPS-R was adapted from the Faces Pain Scale (FPS) in order to make it possible to score on the widely accepted 0 to 10 metric. It shows a close

linear relationship with visual analogue pain scales across the age range of 4-16 years old. It is easy to use and requires no extra equipment except for the photocopied faces. Child was asked to score the chosen face 0, 2, 4, 6, 8, or 10, counting left to right, so '0' = 'no pain' and '10' = 'very much pain.' Did not use words like 'happy' and 'sad.' This scale intended to measure how children feel inside, not how their face looked [El-Sharkawi et al., 2012; Hoge et al., 2012; Frere et al., 2001; Tomlinson et al., 2010] (Fig. 3).

Heart rate

Heart rate (HR) was measured using an automatic blood pressure and heart rate monitor (SEM-2 Omron Healthcare Co., Ltd, China) by placing the blood pressure cuff above the knee and auscultated the popliteal artery. Heart rate was recorded before treatment and during the 4 periods mentioned above [Uehara et al., 2012].

Child pain-related behaviour measurement

Two professional paediatric dentists assessed the distress behaviour by playing back the video record of each dental visit. Movement of each patient also measured during 4 sessions as mentioned above using the face, legs, activity, cry and consolability scale (FLACC). Each of FLACC's 5 categories; (F) face, (L) legs, (A) activity, (C) cry, and (C) consolability was score between "0" to "2", which results in a total score between "0" to "10". With 0 indicating the face; No particular expression or smile, legs; Normal position or relaxed, activity; Lying quietly, normal position, moves easily, cry; No cry (awake or asleep) and consolability scale; Content, relaxed. With 1 indicating the face; Occasional grimace or frown, withdrawn, disinterested, legs; Uneasy, restless, tense, activity; Squirming, shifting back and forth, tense, cry; Moans or whimpers, occasional complaint and consolability scale; Reassured by occasional touching, hugging, or being talked to, distractible. With 2 indicating the face; Frequent to constant frown, clenched jaw, quivering chin, legs; Kicking or legs drawn up, activity; arched, rigid, or jerking, cry; Crying steadily. screams or sobs; frequent complaint and consolability scale; Difficult to console or comfort [Merkel et al., 1997; von Baeyer et al., 2007; Nilsson et al., 2008].

All three measurements mentioned above have been widely used and provided validity and reliability from reliable systemic reviews [Nilsson et al., 2008]. Dentists conducted the assessment from the video of each visit. The judgement from both dentists was in consensus. The video was reassessed again within 1 month for the intra examiner reliability using Kappa co-efficiency test.

Statistical analysis

Qualitative data which are gender, previous dental experience, treatment arch and treatment performed between 2 groups were tested for distribution using Shapiro-Wilk test. Pearson's chi-square test would be used if data was normally distributed. Fisher's exact test

would be used if data was not normally distributed. For quantitative data which are age and treatment time in both visits between 2 groups were also tested for distribution using Shapiro-Wilk test. Two sample t-test would be used if data was normally distributed. Mann-Whitney U test would be used if data was not normally distributed [Altman. 1991]. HR, FPS-R and FLACC scales between 2 visits were tested for data distribution using Shapiro-Wilk test. T-independence test would be used if data was normally distributed. Mann-Whitney U tests would be used if data was not normally distributed. All statistic tests were at a 95% level of confidence and the significant level was at 0.05. Kappa co-efficiency was used to analyse the inter variable between two dentists when rating distress behaviour using FLACC scale.

Results

Participants

Forty-eight participants were enrolled in the study. Six children were excluded. One failed to return for a second visit. Four were not able to rate their behaviour due to video mechanical problems and the other participant refused to wear AV eyeglasses in second visit. At the end of the study, 42 participants remained. Sixty-two percent were girls and 38% boys. Mean ages of all subjects was 82.83 ± 11 months old. Twenty one percent, 41% and 38% of subjects had an experience in dental treatment with the local anaesthetic injection, had dental treatment without the injection and never had any dental treatment before, respectively. In this study, 26% and 74% received treatment in the maxillary and mandibular arch, respectively. Treatment performed from the highest were extraction and fillings (33%), only filling (31%), filling and stainless steel crown (19%), only stainless steel crown (10%) and pulp treatment in primary teeth (7%), respectively. There was no significant difference in gender ($p=0.204$) and treatment arch ($p=0.292$) using Chi-square test at $p<0.05$, previous dental experience ($p=0.381$) and treatment received ($p=0.835$) using Fisher's exact test at $p<0.05$, age ($p=0.384$, T-test at $p<0.05$), and treatment time (1st visit: $p=0.465$, 2nd visit: $p=0.89$, Mann-Whitney U test at $p<0.05$) between 2 groups (Table 1).

Pain and Anxiety Measurements

Group I showed mean pain score of 1.62 ± 2.94 and 0.86 ± 1.49 when not wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit, respectively. Group II showed mean pain score of 1.9 ± 2.93 and 1.9 ± 3.32 when wearing AV eyeglasses in the first visit and not wearing the eyeglasses in a second visit, respectively.

Subject who reported maximum score on pain rating scale when not wearing AV eyeglasses and wearing the eyeglasses were 7.1% and 2.4%, respectively.

Characteristics		Total (N=42)	Group I ^a (N=21)	Group II ^a (N=21)	Intergroup p-value
		N (%)	N (%)	N (%)	
Gender	Male	16 (38%)	10 (48%)	6 (29%)	0.204 ^C
	Female	26 (62%)	11 (52%)	15 (71%)	
Age (month)		82.83±11.00	81.33±11.10	84.33±10.97	0.384 ^T
Previous dental tx.	Treatment with the injection	9 (21%)	3 (14%)	6 (29%)	0.381 ^F
	Treatment w/o the injection	17 (41%)	8 (38%)	9 (43%)	
	Never had any dental treatment	16 (38%)	10 (48%)	6 (29%)	
Treated area	Maxilla	11 (26%)	4 (19%)	7 (33%)	0.292 ^C
	Mandible	31 (74%)	17 (81%)	14 (67%)	
Treatment performed	Filling	13 (31%)	7 (33%)	6 (29%)	0.89 ^M
	SSC	4 (10%)	3 (14%)	1 (5%)	
	Filling and SSC	8 (19%)	4 (19%)	4 (19%)	
	Extraction and filling	14 (33%)	6 (29%)	8 (38%)	
	Pulp tx	3 (7%)	1 (5%)	2 (10%)	
Treatment time	Visit 1	28.74±11.56	27.29±10.61	29.48±11.29	0.835 ^F
	Visit 2	26.67±9.79	26.05±9.12	28±12.05	0.465 ^M

Group I: not wearing the AV eyeglasses → wearing the AV eyeglasses
 Group II: wearing the AV eyeglasses → not wearing the AV eyeglasses
 C = Chi-Square test at significantly level of 0.05, T = Independent t-test at significantly level of 0.05
 F = Fisher's exact test at significantly level of 0.05, M = Mann-Whitney t-test at significantly level of 0.05

TABLE 1 Participant characteristics, previous dental experience, treatments arch, treatment performed and treatment time between two groups.

Treatment step	Group	Heart rate (mean±SD)		Intergroup p-value		
		Visit 1	Visit 2	Eyeglasses effect	Period effect	Carry-over effect
Pre-operation	I	94.57±15.09	88.14±10.07	.043*	.241	.484
	II	88.06 ±12.74	89.86±12.11			
Rubber dam placement	I	101.86±15.24	95.38±11.56	.786	.002*	.898
	II	100.86±13.97	95.38±14.68			
First use of high speed hand piece	I	101.43±12.86	97.76±12.26	.921	.049*	.577
	II	99.57±14.85	95.52±13.09			
During the remaining tx	I	96.96±11.90	93.15±9.81	.871	.035*	.633
	II	95.24±12.11	91.96±10.50			

Group I: not wearing the AV eyeglasses → wearing the AV eyeglasses
 Group II: wearing the AV eyeglasses → not wearing the AV eyeglasses
 *T = Significantly different using independent t-test (p<0.05)

TABLE 2 Heart rate between 2 groups in both visits during restorative dental treatment.

Heart rate

There was no difference of baseline HR between 2 groups in both visits. In table 2, in pre-operation, group I showed mean HR of 94.57±15.09 and 88.14±10.07 when not wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit, respectively. Group II showed mean HR of 88.06±12.74 and 89.86±12.11 when wearing AV eyeglasses in the first visit and not wearing the eyeglasses in a second visit, respectively. Wearing AV eyeglasses during pre-operation period significantly reduced HR when compared with not wearing the eyeglasses (p=0.043, T test at p<0.05). We also analysed the period effect (the experience from

the first visit might affect the following visit) and carry-over effect (the distraction effect obtained from AV eyeglasses might carry over into the next visit). Results showed that HR were significantly reduced during rubber dam placement (p=0.002, T test at p<0.05), during the first used of high speed hand piece (p=0.049, T test at p<0.05) and during remaining treatment (p=0.035, T test at p<0.05) which resulted from the period effect.

Child pain-related behaviour measurement

Kappa statistic values for the FLACC on face, legs, activity, cry, and consolibility were 0.771, 0.739, 0.733, 0.851, and 0.754, respectively. The strength of

Treatment step	Group	FLACC score (mean+SD)		Intergroup p-value		
		Visit 1	Visit 2	Eyeglasses effect	Period effect	Carry-over effect
Pre operation	I	0.57+0.98	0.1+0.3	0.018*	0.800	0.611
	II	0.1+0.3	0.38+0.8			
Rubber dam placement	I	1.29+1.45	0.81+1.33	0.476	0.351	0.806
	II	1.1+1.48	1+1.26			
First used of high speed hand piece	I	0.43+0.87	0.14+0.36	0.047*	0.645	0.158
	II	0.33+1.11	0.81+1.47			
During the remaining tx	I	0.57+0.98	0.33+0.73	0.729	0.313	0.334
	II	0.95+1.63	0.71+1.1			

Group I: not wearing the AV eyeglasses → wearing the AV eyeglasses
Group II: wearing the AV eyeglasses → not wearing the AV eyeglasses
* Significantly different using Mann-Whitney U test (p<0.05)

TABLE 3 FLACC score between 2 groups in both visits during restorative dental treatment.

agreement of leg and activity kappa scores was good and the others were very good. The weighted kappa coefficient was 0.83 for total score ($p < 0.001$) showed the excellent agreement for five categories of the FLACC scores. Both groups showed lower FLACC scores when wearing AV eyeglasses. In table 3, during pre-operation, group I showed mean FLACC score of 0.57 ± 0.98 and 0.1 ± 0.3 when not wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit, respectively. Group II showed mean FLACC score of 0.1 ± 0.3 and 0.38 ± 0.8 when wearing AV eyeglasses in the first visit and not wearing the eyeglasses in a second visit, respectively. During the first use of high speed hand piece, group I showed mean FLACC score of 0.43 ± 0.87 and 0.14 ± 0.36 when not wearing AV eyeglasses in the first visit and wearing the eyeglasses in a second visit, respectively. Group II showed mean FLACC score of 0.33 ± 1.11 and 0.81 ± 1.47 when wearing AV eyeglasses in the first visit and not wearing the eyeglasses in a second visit, respectively. Wearing AV eyeglasses during the first use of high speed hand piece significantly reduced FLACC scores when compared with not wearing the eyeglasses ($p = 0.047$, Mann-Whitney U test at $p < 0.05$). FLACC scores in group I and II were significantly different in pre-operation ($p = 0.018$) and the first used of a high speed hand piece ($p = 0.047$, Mann-Whitney U test at $p < 0.05$). No period effect and carry over effect of FLACC score were found in both groups.

Discussion

Results from previous studies did not clearly differentiate which restorative procedure benefited from wearing AV eyeglasses [Ram et al., 2010]. The procedures that are more invasive, such as pulp treatment or extraction, are more difficult and could gain more benefit when wearing AV eyeglasses as an adjunct distraction technique when

compared with easy procedure such as prophylaxis. This study was designed as a crossover study in order to eliminate any difference in pain and anxiety threshold between each subject which could bias the results [Ram et al., 2010]. The advantage of a crossover study is that each subject would be compared to themselves in both experiment and control situations. However, a criticism of this design is that the effect of a treatment on a subject may be influenced by previous treatment which called a carry-over effect. The carry-over effect may continue to work and it may enhance or cancel out the effect of the intervention [Ram et al., 2010]. In this study, certain considerations such as the length of a wash out period or subjects assignment method, were followed a crossover research design recommendation in order to guard against a carry-over effect [Wellek and Blettner, 2012]. This study showed that AV eyeglasses effectively reduced HR in pre-operation period. However, when period effect was analysed, HR was lower during rubber dam application, the first use of a high speed hand piece and during the remaining of treatment procedures. This is not unexpected. Venham et al. [1981] reported previously when compared two dental visits in children aged 3-8 years old, they found that anxiety level significantly decreased and cooperative behaviour increased during dental treatment in second visits. Howitt and Stricker measured HR of 8-14 years old children during a series of dental visits [Howitt and Stricker, 1970]. They reported that the highest HR was detected during treatment visits, and significantly lower during the exam visit. The lowest HR was detected during the six-month recall exam. Previous studies regarding child dental experience concluded that child's arousal level was reduced as they got accustomed to the dental environment and procedures [Venham et al., 1981; Ram et al., 2010].

There are many different self-reporting pain intensity scales used to measure pain in children. Most commonly used are faces scales, numerical rating scales, visual

analogue scales, and the Wong-Baker FACES pain rating scale [Ram et al., 2010; Tomlinson et al., 2012; Uehara et al., 2012]. In this study, the Faces Pain Scale-Revised (FPS-R) was used. This is similarly to one in a previous study by Hoge et al. that evaluated the effectiveness of AV eyeglasses during dental restorative treatment in children. Their results also showed no difference in child pain perception assessed by this scale [Aitken et al., 2002].

FLACC is indirectly related to child's distress and anxiety level. Our results showed that AV eyeglasses effectively reduced child's physical distress in pre-operation period and the first use of high speed hand piece. However, FLACC score during the remaining of restorative treatment was not significantly decreased. This study added extra information on this point because results from previous study reported as a whole restorative procedure which might not accurately exhibit a true outcome. During restorative treatment, child's anxiety level is not flatly displayed in a monotone level but rather increase during critical steps such as using a high speed hand piece, injection of a local anaesthesia, and extraction. Many studies reported a strong association between invasive dental procedures and dental anxiety [Venham et al., 1981; Ram et al., 2010].

The limitation of this study is that FLACC score was assessed by playing back the video record of each visit by 2 paediatric dentists which could not be blind to the child's use of the AV eyeglasses. In the beginning of this study, we tried to control the bias by letting subjects wear the AV eyeglasses without playing any movies. With several trying, we found that a lot of subjects were uncomfortable and reported that they felt scared. Since the success of the AV eyeglasses distraction technique depends on the programme played, without playing any movies would be difficult for children to wear the eyeglasses until the end of dental treatment. One girl subject aged 7 years old had some dental treatments without local anaesthetic before she participated in this study. She was quite nervous and kept asking which instruments would be used and what procedures would be performed. She was anxious and refused to wear the AV eyeglasses. Dahlquist found that children who presented with high trait anxiety did not respond well with this type of distraction [Dahlquist et al., 2009]. Another study of virtual reality found that the children who insisted to focus on dental treatment procedure presented high anxiety because they felt a lack of control if their visual field is blocked by the device [Sharar et al., 2007].

Conclusion

AV eyeglasses successfully reduced HR and physical distress during pre-operation and the first use of high speed hand piece. It could be used as an adjunctive distraction technique during dental treatment in children.

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