The long-term effect of dental treatment under general anaesthesia or physical restraints on children's dental anxiety and behaviour

F. Zhou[1-2], S. Zhang[1], W. Ma[1], Y. Xiao[1], D. Wang[1], S. Zeng[2], B. Xia[1]

[1]Department of Paediatric Dentistry, Peking University School and Hospital of Stomatology, National Engineering Laboratory For Digital and Material Technology of Stomatology, Beijing Key Laboratory of Digital Stomatology, Beijing, PR China
[2]Department of Paediatric Dentistry, Affiliated Stomatology Hospital of Guangzhou Medical University,Guangdong Engineering Research Center of Oral Restoration and Reconstruction, Guangzhou Key Laboratory of Basic and Applied Research of Oral Regenerative Medicine, Guangzhou, Guangdong, PR China

E-mail: zhoufeng_3120@163.com

DOI 10.23804/ejpd.2022.23.01.05

Abstract

Aim Dental anxiety (DA) is a common problem worldwide because it renders dental treatment in children challenging. This study aimed to evaluate the long-term effect of dental treatment under general anaesthesia (GA) or physical restraints (PR) on children's DA and behaviour.

Methods A total of 103 children were recruited and divided into four groups: the GA group, PR group, cooperative (CO) group, and no experience (NE) group. The face version of the Modified Child Dental Anxiety Scale and modified Venham's Clinical Anxiety and Cooperative Behaviour Rating Scale were used to evaluate the level of DA and behaviour.

Results The DA score of the GA group was significantly higher than that of the NE group (P=0.033). Children who underwent GA in the past were considered to be at a higher risk for DA than those who had been submitted to PR or those without previous dental experience. The behaviour rating was lowest in the CO group (P<0.05), while no significant differences were found for other groups. A positive relationship was demonstrated between DA scores and behaviour, but the agreement was just moderate.

Conclusions Dental treatment under GA is associated with a higher risk for DA when compared with that under PR in the long term. Increased DA may lead to uncooperative dental behaviour, although the agreement is only moderate.

KEYWORDS Anxiety; Dental; Behaviour, General anaesthesia; Physical restraints.

Introduction

Dental anxiety (DA) in children is one of the major problems faced by paediatric dentists. Because of the differences in age, region, culture, and evaluation method, the prevalence of DA varies between 5.7% and 59% in children [Su et al., 2007;Wogelius et al., 2003]. DA can lead to dental behaviour management problems (DBMPs), the avoidance and delay of dental care, and worse oral health, which may also develop into a vicious cycle of DA in children [Armfield et al., 2007].

The aetiology of DA is multifarious and complex. It has been reported that several factors contribute to the development of DA among children, including factors such as age [Wogelius et al., 2003], gender [Barreto et al., 2017; Bezabih et al., 2013; Muppa et al., 2013], temperament [Klingberg and Broberg, 1998], and heredity [Ray et al., 2010], family factors such as socioeconomic status [Armfield et al., 2006; Barreto et al., 2017] and the family's DA [Armfield et al., 2006; Ollendick and King, 1991]), and dental experience [Carrillo-Diaz et al., 2012; De Jongh et al., 2002; van Wijk and Hoogstraten, 2005].

To alleviative the anxiety of children and improve compliance to dental treatment, behaviour guidance techniques have been recommended, both pharmacological and non-pharmacological [Cianetti et al., 2017]. General anaesthesia (GA) is an alternative pharmacological intervention and allows dental practitioners to complete all dental treatments in a single visit. Nevertheless, physical restraints (PR), which is characterised by a forced restricted movement of the patient, is a kind of non-pharmacological techniques and usually requires multiple visits.

GA is considered a traumatic treatment for children because of the fear during anaesthesia induction and postoperative complications following treatment with GA [Hosey et al., 2006]. A few studies reported that children who had undergone dental treatment with GA have greater DA than those without a history of GA [Aldossari et al., 2019; Haworth et al., 2017; Howard and Freeman, 2007]. On the contrary, some studies showed a reduction or no change in DA within 2–4 weeks following GA [Yıldırım et al., 2018; Zhang et al., 2015].

PR has always been considered controversial worldwide. On the one hand, children undergoing PR probably experience the positive feeling of having coped with a difficult situation by their own effort and effectively communicate with the dentist during treatment, thus leading to a possibility of changing their negative attitude towards dental treatment.

On the other hand, it has the potential to cause serious consequences, such as physical or psychological harm which might affect the future dental behaviour of children in a negative manner. Very few studies focus on the change in DA and behaviour after PR. In our previous study, we reported an improvement in dental behaviour, but not a significant elevation in DA, when comparing between pre- and post-treatment under PR within 2 weeks [Zhang et al., 2015].

However, there has been no investigation comparing the long-term effect of dental treatment under GA and PR on children's DA and behaviour. Thus, the aim of this study was to compare the DA and dental behaviour between children who had previously undergone GA for 2–3 years and children who underwent PR.

Methods

This is a cross-sectional study. The sample population of children was selected from the from the Department of Pediatric Dentistry, Peking University School and Hospital of Stomatology, from June 2015 to January 2017. All parents provided informed consent. Ethical approval was obtained from the Human Research Ethical Committee of the University Medical Science Centre (no. PKUSSIRB-2013001).

Participants

The samples were divided into four groups: the general anaesthesia (GA), physical restraint (PR), cooperative (CO), and no experience (NE) group. The flowchart of study participant selection is presented in Figure 1, and the inclusion criteria of each group were as follows.

- The children who had dental treatment under GA (n=21) or PR (n=30) in our previous study [Xiao et al., 2014] were recalled after 2–3 years. In the mentioned previous study either GA or PR was chosen based on the child's condition as assessed by a dentist with the parents' consent. The inclusion criteria for GA and PR participants were: decayed/missing/filled teeth (dmft) ≥4 diagnosed and received dental treatment under GA or PR at 2 to 4 years of age; no systemic diseases or mental limitations; regular dental visit (more than once after treatment); aged less than 7 years when recalled.
- The CO group comprised children who were cooperative during dental treatment and had not experienced GA or PR. The inclusion criteria for this group of participants were: 4 to 6 years old; dmft ≥4 diagnosed at 2–4 years of age) and more than two dental treatments, including filling, tooth extraction, and pulp therapy, but not including pit and fissure sealing, which had been conducted by specialists; no systemic diseases or mental limitations.
- The inclusion criteria of the NE group were: dmft ≥4 diagnosed at 4–6 years of age; first dental visit and without any dental treatment in the past; no systemic diseases or mental limitations.

All children who attended the Department of Pediatric Dentistry, Peking University School and Hospital of Stomatology from June 2015 to January 2017 were examined by paediatric dentists and met the inclusion criteria of the CO and the NE group were selected and enrolled in this study. The sample size roughly matched the two other groups, which was between 20 and 30 children (Fig. 1).

Questionnaire

The participants' general information and dental pain were recorded. Oral hygiene was evaluated by the clinicians using the dmft index and the plaque index (PLI).

Self-report scales are the most common methods for assessing DA. The Modified Child Dental Anxiety Scale (MCDAS) based on Corah's Dental Anxiety Scale for adults is composed of eight questions about dental procedures, including examination, cleaning, local anaesthesia, filling, extraction, dental general anaesthesia (DGA), and relative analgesia (RA). A five-point Likert scale is used to represent the level of DA, and the scores range from 5 (little or no DA) to 40 (extreme DA). As the scale is unsuitable for very young children, Howard et al. [2007] proposed the face version of the scale (MCDASf), which added a face rating scale to the numeric form, making it easy for younger children to understand. In 2013, the MCDASf was translated into Chinese and demonstrated to have a good reliability and validity for Chinese children aged 4–11 years [Zhang et al., 2013]. In this study, we employed the scale to assess the level of DA. Face-to-face interviews were conducted by the researchers using the same description. Children with a score >19 were considered to have DA, while having a score ≤19 was considered as non-DA.

The modified Venham's Clinical Anxiety and Cooperative Behaviour Rating Scale was used, which has been translated into Chinese and modified for children aged 2–8 years and has been considered as good inter-rater reliability and excellent intra-rater reliability [XiA et al., 2007]. The children's behaviour during dental treatment was assessed from 0 to 5 by a researcher, previously trained.

The children who had undergone GA or PR in our previous study were recalled and made an appointment by telephone. Then, all questionnaires were completed during the recall visit. Among the patients who were routinely revisited by the

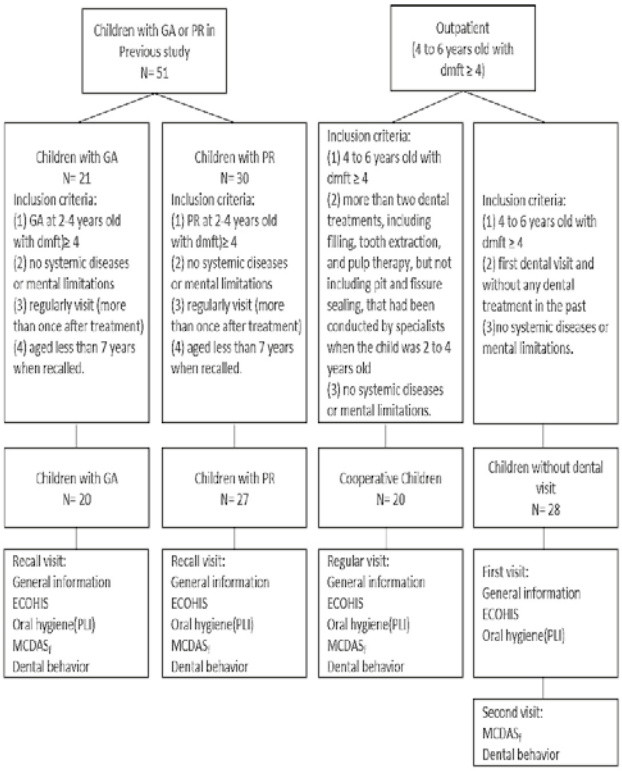

FIG. 1 The flowchart of participants.

three dentists, all questionnaires were completed in a single visit as long as they met the inclusion criteria of the CO group. However, for children in the NE group, the general information, dental pain experience, and oral examination were recorded at the first visit. The children's behaviour during dental treatment was assessed by a researcher, and the MCDASf was completed by themselves at the second visit.

Statistical analysis

The data were digitised and tabulated in Microsoft Excel (Microsoft, Redmond, WA, USA). All analyses were carried out using SPSS 25.0 software (SPSS Inc., Chicago, USA). Differences with P values <0.05 were regarded as statistically significant. The relationships between two continuous variables were analysed using the t-test, while the one-way analysis of variance (ANOVA) model and the post hoc test for pairwise comparisons were used to compare more than two continuous variables. In addition, the categorical variables were analysed using the chi-square test or non-parametric test. A multiple logistic regression was fitted, with the assessment of the child as being DA (1) and non-DA (0) as the dependent variable. The independent factors included age, sex, dmft, PLI, caregiver, parents' educational level, and dental experiences (referring to the four groups). Given the sample size, initially, univariate logistic regression analyses were conducted to primarily determine which variables were more likely associated with DA at the 0.2 probability level. Then, the selected factors were included into the final model. Assessment of the correlation between DA and behaviour was performed using Spearman's correlation coefficient.

Results

Participants' general information and DA

A total of 103 children participated in this study (21 in the GA group, 30 in the PR group, 23 in the CO group, and 29 in the NE group). Eight children were excluded because of incomplete information, and 95 children were finally included in the analysis (20 in the GA group, 27 in the PR group, 20 in the CO group, and 28 in the NE group). In total, 45 were girls and 50 were boys. The demographic and clinical characteristics of the sample population are shown in Table 1. There was a significant difference in gender (P=0.047), age (P<0.001), and dmft (P=0.001). No significant differences were observed in PLI (P=0.656), caregiver (P=0.482), parents' educational level (P=0.369), and dental pain experience (P=0.560). In addition, the number of teeth undergoing endodontic treatment and extraction was significantly different between GA (5.30 ± 2.83) and PR (1.82 ± 1.69) groups (P<0.01). The median number of visits for treatment in the PR group was four (interquartile range, 2 visits) (Table 1).

The DA scores are shown in Table 2. The mean overall score for the MCDASf was 19.26±6.61. After post hoc multiple comparisons, the mean score of the GA group was statistically significantly higher than that of the NE group (P=0.033), but there was no difference for the other groups. In the eight items, 'having an injection in the gum' and 'having a tooth taken out' garnered the highest mean anxiety scores (2.87±1.42 and 3.44±1.34, respectively) in comparison to other items with lower scores such as 'going to the dentist' (P<0.001). Significant differences among the four groups concerning injection in the gum and RA (P=0.029 and P=0.019, respectively) were noted. Moreover, children who had no dental experience previously had statistically significantly greater mean scores than the children in the GA or PR group for the item 'having an injection in the gum' (P=0.005 and P=0.022, respectively). In addition, a higher mean score was noted in children who had GA previously compared to the children in the PR or NE group in terms of RA usage (Table 2).

The DA scores were converted into a binary variable indicating DA and non-DA by a cut-off score of 19. The independent variables and univariate associations with DA are summarised in Table 3. The variables including caregiver, parents' educational level, pain experience, and dental experience were entered into the final multivariable logistic regression model (Table 4). The results confirm that children who had previous GA experience were four times (1/0.235) more likely to be anxious than those who had dental treatment

		GA (n=20)	PR (n=27)	CO (n=20)	NE (n=28)	Statistics	P value
Gender	Girl Boy	10 (50.0) 10 (50.0)	7 (25.9) 20 (74.1)	13 (65.0) 7 (35.0)	15 (53.6) 13 (46.4)	Chi-squares =7.961	0.047
Age (years)		5.34 ± 0.69	5.68 ± 0.58	5.47 ± 0.72	4.83 ± 0.56†	F = 8.913	< 0.001
dmft		15.10 ± 5.13‡	9.52 ± 4.23	10.35 ± 2.39	10.89 ± 4.28	F = 6.470	0.001
PLI		1.37 ± 0.64	1.37 ± 0.74	1.28 ± 0.50	1.51 ± 0.56	F = 0.540	0.656
Caregiver	Parents Grandparents	19 (95.0) 1 (5.0)	24 (88.9) 3 (11.1)	20 (100.0) 0 (0.0)	26 (92.9) 2 (7.1)	Kruskal-Wallis H = 2.469	0.482
Education of parents	Both parents≥college At least one below college	18 (90.0) 2 (10.0)	21 (77.8) 6 (22.2)	19 (95.0) 1 (5.0)	24 (85.7) 4 (14.3)	Kruskal-Wallis H = 3.148	0.369
Pain experience		2.40 ± 1.50	2.19 ± 0.88	2.30 ± 0.92	1.96 ± 1.10	F = 0.691	0.560

The results of age, dmft, PLI, and pain experience are given as the mean (`x ± s), and the others are given as the number (N [%]). dmft = decayed-missing-filled teeth; PLI = plaque index; GA = general anesthesia group; PR = physical restraints group; CO = cooperative group; NE = no experience group.
† The mean age of children in NE group was respectively lower than other three groups, P values were less than 0.01. There were no significant differences for other three groups (post hoc test).
‡ The mean dmft of children who have GA experience was respectively higher than other three groups, P values were less than 0.01. There were no significant differences for other three groups (post hoc test).

TABLE 1 General demographic and clinical characteristics of the children.

	GA (n = 20)	PR (n = 27)	CO (n = 20)	NE (n = 28)	Total	F	P value
Q1: Going to the dentist	2.10±1.25	2.15±1.29	1.95±0.94	1.93±1.33	2.03±1.22	0.196	0.791
Q2: Teeth looked at	2.30±1.34	1.96±1.13	2.05±0.89	1.96±1.20	2.05±1.14	0.416	0.722
Q3: Scraped and polished	2.50±1.24	2.07±1.21	2.50±1.28	2.04±1.07	2.24±1.19	1.087	0.352
Q4: Injection in the gum	3.45±1.47	3.15±1.49	2.75±1.29	2.29±1.24‡	2.87±1.42†	3.295	0.029
Q5: Filling	2.45±1.57	2.41±1.45	2.45±1.32	2.29±1.30	2.39±1.39	0.077	0.979
Q6: Tooth taken out	3.55±1.28	3.19±1.42	3.50±1.15	3.57±1.56	3.44±1.34†	0.447	0.682
Q7: DGA	2.45±1.61	2.15±1.20	2.00±1.12	1.61±0.99	2.02±1.25	1.975	0.149
Q8: RA	2.85±1.35§	2.00±1.07	2.40±1.10	1.82±0.91	2.21±1.15	3.972	0.019
Total score	21.65±7.49	19.07±7.34	19.60±5.43	17.50±5.70¶	19.26±6.61	1.586	0.198

DGA = dental general anesthesia; RA = relative analgesia; GA = general anesthesia group; PR = physical restraints group; CO = cooperative group; NE = no experience group.
† For all samples, the mean scores of Q4 and Q6 were relatively higher than other items (post hoc test, P < 0.05).
‡ The mean score of Q4 in NE group was lower than GA and PR groups respectively (post hoc test, P = 0.005, P = 0.022).
§ The mean score of Q8 in GA group was higher than PR and NE groups respectively (post hoc test, P = 0.01, P = 0.002).
¶ The mean total score in NE group was lower than GA group (P = 0.033), no significant differences were noted for other groups (post hoc test).

TABLE 2 Comparison of the scores of the Chinese version of MCDASf among the groups (`x ± s).

under PR, and seven times (1/0.137) more likely to be anxious than children without previous dental experience. Interestingly, no significant difference was found between CO and GA for the risk of being anxious (P=0.075). In addition, children whose at least one parent is below college level were eight times more likely to be anxious than those whose both parents are college level and above (Table 3, 4).

Dental behaviour

Prior to the assessment, the researcher conducted a standard consistency test with the expert who revised the scale and the agreement was almost perfect (kappa=0.81). The distributions of children's behaviour during dental visit according to the dental experience and level of DA are shown in Table 5. Behaviour rating was lowest in the CO group (P<0.05), while no significant differences were found for the three other groups. In addition, children's uncooperative behaviour was higher in those who had DA compared to the children with non-DA (P<0.001) (Table 5).

DA scores and behaviour demonstrated a positive correlation in this study (Spearman's correlation=0.43, P<0.001). This meant that when the anxiety level increased, uncooperative behaviour correspondingly increased.

Discussion

This study investigated the DA and behaviour between children who had undergone GA or PR more than 2 years prior and children who had not, including the children who were cooperative and had not received GA or PR during dental treatment and those with no previous experience of dental visits.

Independent Variables	Category	non-DA (MCDASf≤19)	DA (MCDASf>19)	Exp (B)	95% CI for Exp (B)	P value
Gender	Girl Boy	22 (46.8) 25 (52.2)	23 (47.9) 25 (51.0)	0.957	0.427-2.141	0.914
Age (years)		5.30 ± 0.72	5.33 ± 0.70	1.069	0.602-1.899	0.819
dmft		10.91 ± 4.20	11.60 ± 4.92	1.183	0.757-2.141	0.460
PLI		1.38 ± 0.65	1.40 ± 0.59	1.041	0.538-22.092	0.904
Caregiver	Parents Grandparents	46 (97.9) 1 (2.1)	43 (89.6) 5 (10.4)	5.233	0.587-1.848	0.138
Education of parents	Both parents ≥ college At least one below college	45 (95.7) 2 (4.3)	37 (79.2) 11 (20.8)	6.689	1.394-32.094	0.018
Pain experience		2.02 ± 0.92	2.35 ± 1.25	1.329	0.906-2.014	0.145
Dental experience	GA PR CO NE	5 (10.6) 13 (27.7) 11 (23.4) 18 (38.3)	15 (31.6) 14 (29.2) 9 (18.8) 10 (20.8)			0.072

The results of age, dmft, PLI, and pain experience are given as the mean (`x ± s), and the others are given as the number (N [%]). dmft = decayed-missing-filled teeth; PLI = plaque index; GA = general anesthesia group; PR = physical restraints group; CO = cooperative group; NE = no experience

TABLE 3 Summary of independent variables and univariate associations with DA.

Variables	B	SE	P value	Exp (B)	95% CI for Exp (B)
Caregiver	1.967	1.174	0.094	7.150	0.716-71.424
Education of parents	2.138	0.851	0.012	8.485	1.600-44.988
Pain experience score	0.181	0.241	0.451	1.199	0.748-1.921
Dental experience	-	-	0.041	-	
PR vs GA	-1.449	0.694	0.037	0.235	0.060-0.915
CO vs GA	-1.259	0.707	0.075	0.284	0.071-1.135
NE vs GA	-1.989	0.700	0.004	0.137	0.035-0.539
Constant	-3.551	1.644	0.031	0.029	

TABLE 4 Results of a multivariate logistic regression analysis for the dependent variable DA/non-DA.

GA = general anesthesia group; PR = physical restraints group; CO = cooperative group; NE = no experience group; B = regression coefficient; CI = confidence interval

GA is considered a traumatic treatment intervention for children because of the fear during anaesthesia induction and postoperative complications following treatment under GA [Hosey et al., 2006]; thus, it is speculated that GA experience would contribute to DA.

This study showed higher DA among children who had previous GA at an earlier time in their childhood. Similar to our results, few investigations reported that children with a previous GA experience had greater DA when compared to children without previous GA experience. In a validity study, DA in children has been demonstrated to be associated with a history of previous GA [Howard and Freeman, 2007]. In another study, greater DA was observed in participants aged 17 years who received GA before the age of 7 years compared to those who had not received GA [Haworth et al., 2017]. It is also highlighted that GA usage poses a high risk for DA as children grow older. In a recent long-term study using two scales, MCDASf and CFSS-DS, DA was extremely statistically greater in the GA group than in the non-GA group [Aldossari et al., 2019]. It was concluded that children who had undergone GA are at a high risk for DA. However, all the previously mentioned works are cross-sectional studies that lack anxiety measurement prior to GA. On the contrary, some short-term reports concluded that there was a reduction or no change in children's DA within 2–4 weeks following GA when compared with pre-treatment data [Yıldırım et al., 2018; Zhang et al., 2015], and this is possibly due to the absence of invasive treatment in short-term subsequent visit in the GA group.

The multivariate analysis highlighted that children who had a history of GA were four times more likely to be anxious than children who had dental treatment under PR. Although children who had undergone GA could complete all required dental treatments in one visit, they have no memory of the treatment and may fail to develop any personal relationship with the dentist and positive attitude towards dental treatment [Kupietzky, 2004]; thus, their DA may not be reduced. On the contrary, children who had undergone PR completed all dental treatments in multiple visits, and they probably experienced effective communication with the dentist, contributing to their attitude change towards dental treatment.

Dental procedures play an important role in the development of DA. The current study assessed DA for eight specific dental procedures in the MCDASf, which include general procedures and other methods that may cause distress in children, such as local anaesthesia, extraction, DGA, and RA. Higher DA was reported when all the children were asked about 'having an injection in the gum' and 'having a tooth taken out'. These results indicated that the cognition of traumatic dental procedures such as injection and extraction can influence DA in children, similar with the results of a previous study [AlGharebi et al., 2020].

Moreover, DA was greater on the item 'having a mixture of gas and air that will help you feel comfortable during the treatment but cannot put you to sleep' in children who had GA experience. We speculate that it may be associated with direct inhalation induction with a mask, rather than premedication before the inhalation as described in other studies owing to the complexity of the procedure at our hospital. However, children who underwent anaesthesia induction with a mask may develop an aversion to the odour or feel of the mask, or have a true phobia of the mask, such as feeling claustrophobic or not being able to breathe [Przybylo et al., 2005]. Thus, we suggest that premedication be used before inhalation induction to improve the sensation of DGA.

As generally known, DA can lead to DBMPs during treatment and manifest as uncooperative and disruptive behaviour, which might result in dental avoidance in adult life and poor oral health. This study noted a positive correlation between DA and dental behaviour, but the agreement was only moderate. It was similar to a study using the MCDASf

Rate groups	0	1	2	3	4	5	Total	P value
GA	2	14	1	3	0	0	20	0.023
PR	8	10	5	2	2	0	27	
CO*	11	8	1	0	0	0	20	
NE	7	15	4	0	2	0	28	
No dental anxiety	21	22	3	1	0	0	47	-0.001
Dental anxiety	7	25	8	4	4	0	48	

Kruskal-Wallis test for comparison among groups. GA = general anesthesia group; PR = physical restraints group; CO = cooperative group; NE = no experience group
** After comparison between two groups, the behavior rating of CO group was better than other three groups, P values were less than 0.05, while no significant differences were noted for other three groups.*

TABLE 5 Children's behaviour during dental visit (N).

and Frankl behaviour rating scale to investigate the relationship between DA and behaviour in children [AlGharebi et al., 2020]. Thus, the children previously without dental experience had the lowest DA, and they displayed uncooperative behaviour that was not significantly different from that of the GA and PR groups, whereas the children in the CO group scored a relatively high DA, and they displayed cooperative behaviour that was lower than that of the three other groups. Several explanations may be adduced for this. Firstly, the children may be effectively managed by a paediatric dentistry specialist using behaviour management techniques. Secondly, they may choose not to express their anxiety, and sometimes even feel brave. Finally, the children were willing to do their best and not manifest disruptive behaviour during dental appointments, despite being anxious. On the contrary, one study reported that there was a low correlation between the behaviour during treatment and children's self-rating anxiety [Folayan et al., 2004], while another study found that self-reported DA was preferable for predicting behaviour during dental visits [Klein et al., 2015].

In a recent study, receiver-operating-characteristic (ROC) curve analysis was used to investigate the optimum cut-off point of MCDAS, which was established to be 20 to detect children with a negative or definitely negative behaviour [Paglia et al., 2017]. In view of the mean score of DA in this population (19.26), we set the score of 19 as a cut-off point to identify 'DA and non-DA'.

There are some limitations to this study. First, as the children in the GA and PR groups were the samples in a previous study [Xiao et al., 2014], the sample size was small and it is difficult to perfectly match the baseline data of each group in the long-term follow-up. Second, this study did not include anxiety measurement prior to GA or PR, so there is no direct comparison between the anxiety level before and after dental treatment under GA or PR.

Conclusions

This study highlights that dental treatment under GA is associated with a higher risk for DA when compared with that under PR in the long term. Thus, dentists should pay more attention to the psychological aspects of children who undergo dental treatment with GA, guiding them to develop a positive attitude towards dental care and good dental behaviour. The findings also suggest that increased DA may lead to uncooperative dental behaviour, although the agreement is only moderate.

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