

Picture exchange communication system as a behavior modification technique for oral health assessment in autistic children

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Objective: The aim of this study was to establish a modality for behavioral intervention for dental management in autistic children using Picture Exchange Communication System (PECS). **Study Design:** A prospective interventional study was carried out on 30 autistic children in the age range of 4–18 years diagnosed with mild to moderate grades of autism to evaluate the effectiveness of PECS in improving oral health over a period of 6 months. **Results:** PECS Phases showed a gradual rise from first to third visit, which was statistically highly significant ($p < 0.001$). Oral Hygiene Index-Simplified (OHI-S) scores improved significantly from first visit and second visit. Definitely substantial correlation was seen between PECS and OHI-S. **Conclusion:** Gradual decrease was observed in OHI-S scores over a period of 6 months, indicating an improvement in the oral hygiene status of autistic children. Gradual progress in Phases of PECS proved to increase cognitive ability of autistic children towards understanding the dental setup related PECS cards.

Keywords: Autism spectrum disorder; Picture exchange communication system (PECS), Simplified, Oral Hygiene Index, Miglani's modification, Tooth-brushing

INTRODUCTION

Individuals with special health care needs exhibit physical, developmental, sensory, behavior, cognitive, and emotional impairments that require medical management and health care interventions. One such disability affecting the world population at a dramatic rate is autism. Autism is a complex neurobehavioral condition that includes impairments in social interaction and communication skills combined with rigid, repetitive behaviour. It is also called as Autism Spectrum Disorder (ASD) as these individuals have a wide range of symptoms. About 1 in 54 children have been identified with ASD according to estimates from Center for Disease Control and Prevention (CDC). It is 4 times more common among boys than girls and no specific etiology for ASD has been identified yet¹. Diagnostic and Statistical Manual of Mental Disorders (DSM-5) published in 2013, provides the most current diagnostic criteria for individuals with ASD². Due to high prevalence of children with autism, dentists are likely to have one or more children with this disorder in their practice. Several factors contribute to poor oral health conditions in children with ASD which includes variable cognition levels; altered saliva levels in the mouth; poor dietary habits; oral habits such as bruxism or pica; poor oral hygiene; motor coordination deficit; and oversensitivity to sensory stimuli. Children with ASD are visual learners and respond better to visual support. To increase communication with autistic children in

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a dental operatory the use of Alternative and Augmentative Communication (AAC) devices and programs can be implemented. One of the most widely used AAC intervention is Picture Exchange Communication System (PECS), it is a unique AAC training package for individuals with autism and similar developmental disabilities. PECS has also been recognized by the American Academy of Pediatric Dentistry as a basic behavior guidance technique³. It is a communication technique developed for individuals with limited to no verbal communication abilities, to express requests or thoughts using symbolic imagery. Dental needs in ASD individuals are similar to those of other patients. Dental professionals might be unaware of difficulties with sensory processing, which is common to patients with ASD. PECS has been used in clinical and educational settings for children with ASD as it is relatively simple to use and teach, inexpensive, and is considered to be a promising intervention.

MATERIALS AND METHOD

A prospective interventional study was conducted after approval (BBDCODS/01/2019.IEC Code 20) from the Institutional Ethical Committee in collaboration with special health-care schools with Autistic Children at East Lucknow region in India after obtaining required consent. A sample of 30 ASD subjects of mild to moderate degree of severity in the age range of 4–18 years, including both males and females were selected for the assessment of oral health status. The degree of severity was assessed on the basis of the Indian Scale for Assessment of autism (ISAA)⁴. ASD individuals with severe degree of severity according to ISAA, and caregivers/parents of autistic children from whom consent was not obtained for oral health evaluation of Picture Exchange Communication System were excluded from the present study.

A three-ring binder was used as a communication board to teach PECS. The binder contained several strips of Velcro (sentence strips), an “I want” card, an “I see” card, “yes” and “no” card, and colourful pictures (2.5 cm by 2.5 cm) of preferred items. These cards were constructed from pictures of dental operatory. The sentence strip was a piece of strengthened paper with Velcro on the bottom and top. The strip was attached to the PECS book on the lower right corner as depicted in Fig. 1.

Prior permission and consent was obtained from the parents by consent forms which were given one week before the clinical examination. Age and details of the subjects were obtained from school records. A detailed information was taken from all the centers regarding the participants degree of autism *i.e.* mild, moderate or severe on the basis of ISAA⁴. The ISAA was chosen in this study as it is seen to be more applicable in Indian population and was being used extensively by most of the autism training centers. The following categories are recommended in ISAA⁴; mild: 70–107, moderate: 108–153, severe: 153. In the first visit, after obtaining an informed consent from the centre, a verbal interactive session for the teachers, supervisors, parents and caregivers was conducted wherein they were educated about the maintenance of oral hygiene and home dental care. It was further ensured that the teachers and parents/caregivers were able to carry out spe-

cific oral hygiene care instructions themselves with the use of Picture Exchange Communication System (PECS), in order to reinforce the participants. PECS cards on oral hygiene maintenance were explained and handed over to both the teachers and parents/caregivers. Participants were examined under natural daylight using a single sided mouth mirror and probe. Evaluation at first visit was done by a single examiner for oral hygiene status using selected indices. The subjects' level of oral hygiene was assessed using the simplified oral hygiene index (OHI-S) as stated by Greene and Vermillion, it is a simple method for assessing a group or an individual oral hygiene levels quantitatively^{5,6}. The OHI-S was developed for the study of variations in gingival inflammation in relation to the degree of intellectual subnormality in children, but has proven useful as an epidemiological tool for evaluating oral health programs in both the general population and disabled groups⁷. For primary dentition, the modified version of the OHI-S by Miglani *et al.*⁸ was used. On completion of oral hygiene evaluation, each participant was individually educated about the oral hygiene care using the Picture Exchange Communication System (PECS) and brushing technique was explained with the help of a model and toothbrush to understand better through tactile senses. PECS Phases were repeated as required for each participant solely on the response received. Criteria for PECS Evaluation-Phase 1—Initial Picture Exchange; Phase 2—Distance Phase and Generalisation; Phase 3—Picture Discrimination; Phase 4—Sentence Structure; Phase 5—Answering Questions; Phase 6—Commenting Phase. The cognitive ability of each subject was assessed on the basis of the Phase of PECS the subject was about to reach at the baseline visit by the same examiner. The subjects were also educated with the same set of PECS cards by the teachers at the center and parents/caregivers at home about oral hygiene care. On the 2nd visit, after 2 months, re-evaluation of the oral health status of the same participants was done with the help of OHI-S and OHI-M. The PECS cards were repeated as required for each participant solely on the response received. The progress in cognitive ability of the subject was re-assessed on the basis of the Phase of PECS. On the 3rd visit, 6 months re-evaluation of the oral health status of the same participants was done. Indian Scale for Autism criteria and oral hygiene scores were recorded and maintained at the 1st visit and 2nd visit and 3rd visit. Records of Oral Hygiene Index and Phases of PECS was maintained throughout the study. The data collected was subjected to statistical analysis.

RESULTS

Statistical Analysis

Data was analyzed using SPSS Version 23.0 (IBM Inc., Chicago, IL, USA). Variables are expressed as mean, standard deviation, number and percentages. Analysis of Variance (ANOVA) was applied to find significant relation between PECS and OHI-S on evaluation of 1st, 2nd and 3rd visit. Chi square test was run to find differences among various categories of autism and oral hygiene practices. *p* value lesser than 0.05 was considered statistically significant.



Figure 1: Self-Designed Picture Exchange Communication System (PECS) Board.

Clinical examiner reliability

Intra examiner reliability in assessing OHI-S was assessed using Kappa coefficient, which depicted adequate agreement with a score 0.94 on first, second and third visit evaluation. Table 1a shows gender distribution where 23 (76.7%) males and 7 (23.3%) females. Mild and Moderate grades of autism were evaluated, 16 subjects (53.3%) were categorized as mild autism and 14 (46.7%) were categorised as moderate autism. Table 1b depicts the age distribution of study population in which the mean age was 9.733 ± 3.675 . Table 2: PECS Phases showed a gradual rise from first to third visit, which was statistically highly significant ($p < 0.001$). Overall increase in the mean values indicates a gradual progress in Phases of PECS demonstrating better cognitive ability towards understanding dental setup related PECS cards which further led to overall improvement in Oral hygiene scores from first to third visit. Table 3 demonstrates the comparison of PECS evaluation at each Phase among mild and moderate autism groups. In the Mild Autism group gradual rise in mean values of PECS was seen from the first visit 2.937 ± 0.997 through second visit 3.125 ± 0.806 , and third visit 4.375 ± 0.957 whereas in the moderate grade of autism mean values of PECS at first visit 2.000 ± 1.037 , second visit 2.357 ± 0.928 and third visit 3.142 ± 1.406 . More improvement was seen in the PECS Phases in mild autism group as compared to the moderate autism group. PECS at first, second and third visit showed significant differences at $p < 0.018$, 0.022 and 0.008 respectively.

Table 4 depicts OHI-S scores improved significantly from the first visit to the third visit ($p < 0.001$). A gradual de-

Table 1a: Gender distribution of study population and category of autism distribution in study population.

Gender	Frequency	Percentage
Males	23	76.7
Mild	10	
Moderate	9	
Females	7	23.3
Mild	6	
Moderate	5	
Total	30	100.0

Table 1b: Age distribution of study population.

Variable	N	Mean \pm S.D	Minimum	Maximum
Age	30	9.733 ± 3.675	16	9.733

S.D: Standard deviation.

crease in OHI-M and OHI-S scores indicated improvement of oral hygiene. Table 5 shows a definitely substantial correlation between PECS and OHI-S. An increase of PECS led to a decrease in OHI-S scores which was highly significant ($p < 0.001$). From first visit to third visit a gradual decrease in OHI-M and OHI-S scores indicated improvement of oral hygiene whereas, gradual progress in Phases of PECS *i.e.* higher value of PECS Phase demonstrated better cognitive ability towards understanding dental setup related PECS Cards which further led to overall improvement in OHI-M and OHI-S scores.

Table 2: Overall PECS phase evaluation for communication from first visit to third visit.

Evaluation—time periods	N	Mean \pm S.D	Std. Error Mean	ANOVA statistic	p value
PECS—First visit	30	2.500 \pm 1.106	0.202	11.020	<0.001**
PECS—Second visit	30	2.766 \pm 0.935	0.170		
PECS—Third visit	30	3.800 \pm 1.323	0.241		

** = Highly Significant; ANOVA—Analysis of Variance; S.D: Standard deviation.

Table 3: Comparison of mild vs. moderate grades of autism during PECS phase evaluation.

PECS—1st visit							
Autism category	N	Mean \pm S.D	Std.Error	Lower bound	Upper bound	ANOVA statistic	<i>p</i> value
Mild Autism	16	2.937 \pm 0.997	0.249	2.405	3.469	6.350	0.018*
Moderate Autism	14	2.000 \pm 1.037	0.277	1.400	2.599		
PECS—2nd visit							
Mild Autism	16	3.125 \pm 0.806	0.201	2.695	3.554	5.880	0.022*
Moderate Autism	14	2.357 \pm 0.928	0.248	1.820	2.893		
PECS—3rd visit							
Mild Autism	16	4.375 \pm 0.957	0.239	3.864	4.885	8.043	0.008*
Moderate Autism	14	3.142 \pm 1.406	0.375	2.330	3.954		

* = Significant; ANOVA—Analysis of Variance; S.D: Standard deviation.

Table 4: Evaluation of OHI-S from baseline to third visit.

Evaluation—time periods	N	Mean \pm S.D	Std. Error Mean	ANOVA statistic	p value
OHI-S First visit	30	2.566 \pm 0.504	0.920	14.827	<0.001**
OHI-S Second visit	30	2.433 \pm 0.504	0.920		
OHI-S Third visit	30	1.800 \pm 0.667	0.667		

** = Highly Significant; ANOVA—Analysis of Variance; S.D: Standard deviation.

Table 5: Correlation of PECS with OHI-S.

Variable	Mean \pm S.D	Correlation coefficient (r)	p value
PECS Phase	3.022 \pm 1.254	-0.450	<0.001**
OHI-S	2.266 \pm 0.667		

** = Highly Significant; S.D: Standard deviation.

DISCUSSION

Dental care is the most common unmet need among the special needs population. Due to a lot of barriers, the child himself may pose various problems to get dental treatment done such as inability to understand the importance of procedure and behave aggressively. Most of the children diagnosed with ASD become uncooperative during treatment as the dental environment poses various challenges such as discomfort, loss of control in an unfamiliar environment and sensory-stimulating activities.

Mehta *et al.*⁹ mentioned in his study that urgent attention is required to plan a comprehensive dental health care programme for Indian children with special needs. Pini *et al.*¹⁰ in his study stated there were high decayed-missing-filled teeth index, as well as inadequate oral hygiene in children with special health care needs.

A clear male predilection was noted in the present study with over 70% (23) boys versus 23.3% (7) girls as seen in Table 1a. This finding is similar to the study by Zink *et al.*¹¹ which shows male ASD individuals were more as compared to females, similar to the findings described by the American Autism Association which reported a prevalence of 4:1 for males in ASD.

Age range of the present study was 9.733 \pm 3.675 years (Table 1b) for a sample population of 30 individuals for evaluating PECS Phases. This is in concordance with the study of Zink *et al.*¹¹ who evaluated 26 individuals with ASD, having an average age range of 10 \pm 3.3 years. Although our study did not focus on the distribution of age of diagnosis, the age 4 years old was selected as it is a cut off age of significance in autism diagnosis. A study by Filipek *et al.*¹² argued that ASD displays its signs before the age of three. An American national study in 2005 found that the average age of diagnosis was 3.1 years for children with autistic disorder, and 3.9 years for pervasive developmental disorders not otherwise specified¹³.

Table 2 shows degree of autism. Based on the Indian scale for assessment of autism (ISAA) only mild and moderate grades of autism were evaluated, as children diagnosed with severe grade of autism were unable to follow PECS at the respective autism centers, and were beyond the scope of the

study. Mild and Moderate grades of autism were evaluated, 16 (53.3%) were categorized as mild autism and 14 (46.7%) were categorized as moderate autism patients.

In the present study PECS showed a gradual rise from first to third visit, which was statistically highly significant at $p < 0.001$. Table 3 showed comparison of PECS Evaluation at each phase amongst mild and moderate autism groups, where greater improvement was seen in the mild group as compared to the moderate group. PECS utilization helped to improve oral hygiene status with oral hygiene level improving from poor to fair and good levels. Scientific evidence supporting the effectiveness of PECS is growing, and general positive outcomes include improved communication between participants and adults across settings, generalized improved communication across new settings, and decreased disruptive behavior.

Table 4 shows that OHIS score improved from first to third visit, demonstrating a significant change in picture comprehension of the ASD children. p value at first, second and third visit for both mild and moderate groups was 0.018, 0.022, 0.008 respectively. PECS facilitated child-dentist communication during dental procedures in the current study. Zink *et al.*¹¹ also reported similarities with preventive treatment facilitation in their study participants.

The present study assessed the improvement in OHI-S for children diagnosed with ASD using PECS; OHI-S scores improved significantly from the first to the second visit and third visit ($p < 0.001$). A gradual decrease in OHI-M and OHI-S scores indicated improvement of oral hygiene. Al-Batayneh *et al.*¹² in their study also reported better gingival health with gingival scores decreasing from first visit to third visit. While Gingival Index scores decreased significantly, Plaque Index scores remained the same in their study. Significant changes in mean Plaque Index between first and second evaluation visits were present whereas, no changes were seen in Gingival Index for children less than 10 years, this could be explained by the fact that the Plaque Index can be changed over a very short period of time depending on tooth brushing while Gingival Index could not be changed, but it requires a relatively longer time duration, due to other predisposing factors for gingivitis such as medications, decreased salivary flow, immune response and oral habits characteristic in children with ASD such as bruxism, tongue thrusting, picking at the gingiva and lip biting. The same factor can be used to explain for the OHI-S scores changing from poor to fair only, as the calculus component in the study will take a long time to bring in difference. Hence, longer evaluation period will be recommended obtaining better scores in OHI-S and Gingival Index.

A definite correlation was found between PECS and OHI-S (Table 5). Oral hygiene of autistic children improved with PECS training. Considerable reduction in OHI-S scores was also noted in the study of Nameeda *et al.*¹³

Picture comprehension in the study population, progressed from “I see” to “I want” for the visuals of toothbrush, toothpaste, applying toothbrush on toothpaste, tap on, water on toothbrush, brush teeth, spit, rinse toothbrush, dental chair, dental light, dental check-up, mouth mirror, good for teeth foods and bad for teeth foods.

At present in home setups, Visual pedagogy—a non-traditional approach to behavior guidance that takes advantage of the ability of children with autism to respond better to pictures rather than words are used, but, unlike PECS assessment of cognitive ability of each subject is not possible. Pilebro and Backman¹⁴ concluded that visual pedagogy was useful in improving oral hygiene in autistic children by placing a series of pictures showing a structured method of toothbrushing in the bathroom or wherever toothbrushing was performed, in 12 months, the amount of visible plaque was reduced and after 18 months, most parents noticed better oral hygiene.

As stated by Crozier *et al.*¹⁵ and Ozdemir¹⁶ Social stories can be implemented in schools as they are short and based on sentences and visual cues. Nevertheless a major drawback with this technique is dependence on reading and auditory processing skills, in such cases video modelling may be an alternative method as mentioned by Mineo *et al.*¹⁷

Moreover, unlike PECS social stories are not interactive and may fail to help the child develop speech. Even video modelling might not transcend barriers of impairment in social communication with humans like PECS does as animations on electronic screen media might impair their ability to initiate social interaction.

For the successful dental visit of autistic child in a dental practice and in dental schools with post graduate programmes the staff should be caring, empathetic, and aware of communication methods for Autistic children, as these children are easily disturbed by stimuli such as sound, light, and taste. Shapiro *et al.*¹⁸ stated that such discomfort may be reduced by introduction of rhythmic music, and deep pressure in the dental environment. Loo¹⁹ suggested that children with ASD have a very limited attention span and hence, short, well-organized appointments with waiting time not exceeding 10–15 minutes should be planned.

Older studies conducted by Kopel²⁰ considered Hand over mouth as an inappropriate technique for these patients, but advocated the use of desensitisation technique which suggested familiarizing the child with basic dental procedures in a step-wise approach. Delpama²¹ mentioned that distraction techniques like watching cartoons, listening to music, or holding toys might help autistic children while undergoing dental procedures.

Friedlander *et al.*²² recommended the use of nitrous oxide inhalational sedation for patients with mild behavior issues. Faulks *et al.*²³ reported that patients with autism have a high success rate of 87.5% with 50% nitrous oxide. An interesting finding reports of methylene tetrahydrofolate reductase (MTHFR) related gene mutations and the dysregulation of folate metabolism in patients with autism²⁴, hence, informed consent for parents and caregivers should include the risks associated in nitrous oxide inhalational sedation.

Aversive techniques such as physical restraints in treating autistic children are controversial. Brill²⁵ suggested application of such techniques in some situations as a protective support device for the patients after informed consent.

As oral health experts in pediatric dentistry we should encourage and influence the use of Picture Exchange Communication System in homes, schools, dental practices, dental

schools with post graduate programmes. According to the ISAA⁴, PECS is not applicable on institutionalised children with severe ASD, as such cases do not respond well to basic behaviour management techniques hence, general anaesthesia is the only treatment option.

A good professional-patient relationship through PECS in the dental environment for ASD individuals can prevent the need to refer such individuals for more extensive procedures in a hospital environment, minimizes the stress and costs of the procedure. Thus, the need to simplify the work environment and create opportunities for communication with ASD patients should be emphasized.

The present study was a prospective interventional type where the participants were regarded as their own controls, and were evaluated at the baseline of the study and in two other occasions during a period of three months. Apparently, poor oral health can result in a negative effect on health and quality of life. Hence, information on oral health status of autistic children would enable pediatric dentists to plan and provide appropriate preventive protocol as well as effective treatment for these patients. PECS can be used a tool for behaviour management in autistic children.

CONCLUSIONS

In this prospective interventional study improvement in oral hygiene status of autistic children was depicted by decrease in OHI-M and OHI-S scores. Progress in Phases of PECS revealed better cognitive ability of autistic children towards understanding the dental setup related PECS Cards.

A good professional-patient relationship through PECS in the dental environment for ASD individuals can prevent the need to refer such individuals for more extensive treatment protocols in a hospital environment, and also minimizes the stress and costs of the procedure. Thus, the need to simplify the work environment and create opportunities for communication with ASD patients should be emphasized.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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