Effectiveness of Picture Exchange Communication System (PECS) on Dental Plaque and Gingival Health of Children with Autism

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By

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Summary:

Background: The need for improved oral hygiene routines in individual with autism has been documented in many reports. Picture Exchange Communication System (PECS), which is a series of pictures that show a structured method and technique for tooth brushing, was chosen for this study.

Aim: The aim of this study was to address this concern and to teach individuals with autism how to brush their teeth using PECS and to evaluate the effectiveness of this on plaque and gingival health of these individuals.

Design: The investigation was a prospective interventional study, including clinical examinations and structured questionnaires. Based on PECS, a series of pictures were produced that showed a structured method and technique of tooth brushing. The pictures were placed in the bathroom, at home and/or at the autism center. Gingival and plaque indices were recorded at each clinical visit. A total of 37 children aged between 3-18 years and their parents/caregivers participated in the study. Data was collected from three examination sessions, and two sets of questionnaires over a 6 months period.

Results: Both gingival and plaque indices dropped significantly between the baseline and 1st re-evaluation visits. However, only plaque index had a significant drop between the 1st and 2nd re-evaluation visit. The results showed a moderate correlation between gingival and plaque indices at the three visit intervals. Age of the child and prior use of PECS had a significant influence on the results, while the sex of the patient did not. Most parents found it hard to use PECS, however, all parents/caregivers agreed that PECS was a helpful tool, and that they would continue to use it.

Conclusion: PECS is a useful tool in helping children with autism to improve their oral hygiene.

Introduction

Autism, first described in 1943 by Dr. Leo Kanner of Johns Hopkins University, is a complex developmental disorder characterized by severe impairment in reciprocal social interaction and communication and by a pattern of repetitive or stereotyped behavior(1). [American Psychiatric Association, 2000]. Individuals with autism are also found to have peculiar cognitive profiles that impact their learning, social, and communicative behaviors including: lack of joint attention, theory of mind, and difficulty with encoding memory task that require multiple cues [Dogoe, 2008](2). Until autism was oficially recognized and included in a new class of disorders; namely the Pervasive Developmental Disorders (PDD) in the early 80's, earlier work on autism was overcome with controversies especially on the validity of the condition [Volkmar et al, 2004](3). Over the years other conditions and categories were used to describe children with autism. The validity of these conditions apart from autism remains a topic of a great interest, debate and research. [Volkmar et al 2005](4). Most recently, classic autism is defined as a group of disorders known as autism spectrum disorders (ASDs). ASDs are developmental disabilities that cause substantial impairments in social interaction and communication and the presence of unusual behaviors and interests (5) [National Center on Birth Defects and Developmental Disabilities (NCBDDD, 2007)].

Since early interventional services may be more effective in autistic children compared to children with other developmental disorders, early identification of autism is of great

Importance(6) [Lipikin et al, 1996]. Aided by practice and guidelines for diagnosis and management of ASDs in children, pediatric clinicians are ideally positioned for the early identification of ASDs(7) [Barbaresiet al, 2006]. In addition, The New York State Department of Health Early Intervention Program [1999](8) stated that in order to evaluate a child with ASD and to differentiate ASDs from other developmental disorders, a comprehensive, multidisciplinary assessment is required. One of the most important aids in identification of ASD is The Modified Checklist for Autism in Toddlers (M-CHAT) (9)[Robins et al, 2001].

Although earlier studies indicated a much lower prevalence of autism, in 2000, the Center for Disease Control and Prevention organized the autism and developmental disabilities monitoring network. A multi-site, record-based surveillance program to study the prevalence of ASDs reported in 2007 that ASD rates for 8-year old children range from 1 in 303 to 1 in 94 for 2 time periods (2000 and 2002) in a total of 14 sites in the United States; the average rate was 1 in 150 or 6.6 per 1000 8-years olds [Center for Disease Control and Prevention, 2000](10). In terms of sex prevalence in ASD, prevalence figures for presentation of ASD in boys and girls have consistently shown that ASD is more common in boys, and there is a significant preponderance of boys with a ratio of 4:1 for classic autism (11) [Ehler et al, 1993].

Personal hygiene, an essential skill of daily living, is typically developed in normal individuals who naturally learn the importance of self care. However for autistic individuals, learning and practicing healthy hygiene behaviors is not easily assured. For people with autism social skills are not naturally acquired and will need direct teaching.

According to Bhalla [2006] (12), the underlying need for an autistic patient is prevention of oral disease. Repeated oral hygiene instructions, and the involvement of parents and care-givers are of paramount importance in oral disease prevention. In a review of the literature, the majority of studies didn't find any increased caries risk or prevalence of periodontal disease in autistic compared with non-autistic individuals [Bhalla, 2006]. At the same time, it is important that dental professionals seek out patients with autism and be able to recognize the signs and symptoms of autism spectrum disorders, both to refer patients to appropriate medical care, and to enable dental treatment of these patients [DePalma et al, 2008](13).

Autistic people tend to be visual learners and will therefore respond better to visual supports rather than the written or spoken word. One method used to enhance learning in persons with autism is the Picture Exchange Communication System. The Picture Exchange Communication System (PECS) is an augmentative communication system developed to help individuals quickly acquire a functional means of communication (14)[Bondy et al, 1994]. PECS combines evidence-based procedures such as choice and preference, time delay, environmental arrangement, and differential reinforcement into a teaching protocol (15)[Kravits et al, 2002]. PECS does not depend on an additional language system, nor any prerequisite skill requirements such as imitation or intentional abilities (16)[Charlop-Christy et al, 2002]. Schwartz et al, [1998] (17)argued that PECS has been accepted and used internationally and nationally in clinical and other settings for children with autism. And that the popularity of PECS can be explained by the fact that it is relatively simple to use and teach, inexpensive, and may facilitate speech [Schwartz et

al, 1998](17). Therefore, promoting healthy hygiene habits and routines in autistic people can be achieved with PECS. PECS give the autistic individual instruction, cues and answers to what, where why and when, helping to teach the autistic individual the importance of healthy hygiene habits.

Methods and Materials

Design and Time Horizon

This investigation was a prospective intervention study, using clinical examinations and structured questionnaires. Data collection involved oral examination for children with autism to be paired with questionnaires answered by their parents or caregivers. A total of 37 children aged between 3-18 years participated in the study. Data was collected from three examination sessions, and two sets of questionnaires over a 6 months period. This study is the first one on the effectiveness of PECS in improving oral hygiene status in our region.

Sample

Study population selection

Participants were solicited by distributing cover letters and consent forms (Appendix I and II) to parents/guardians or direct caregivers of students from two different venues: an after school support group for children with autism spectrum disorder (ASD), and a private autism center. In total, 75 invitations were sent to parents with autistic children to participate in the study.

Inclusion Criteria

The two inclusion criterions were:

1- Child is diagnosed with autism including autism spectrum disorders.

2- Age was between 3 and 18 years old.

Approval

The questionnaire and the study protocol were approved by the Institutional Review Board for Human use (IRB) at Jordan University of Science and Technology

Consent Form

The parents/guardians received verbal and written information about the study. They were also informed that participation is voluntary, and would not affect other contacts with dentistry and that they were free to withdraw from the study at any time without having to explain. They had to sign a waiver and consent form for both the participation of their children, and for their children to be photographed (Appendix VIII).

Questionnaires

Participating parents/guardians or care givers were instructed to complete a questionnaire regarding different aspects of their children's lives. It included child biography, diagnosis, method of communication, dental history, oral hygiene, and the child/parent familiarity with the picture exchange communication system (Appendix III). In addition, parents or caregivers were asked to answer a second questionnaire (Appendix IV) after two weeks from the base line examination to report and assess their child progression and cooperation with the study. Both sets of questionnaires are modified from a previous study done by Pilebro, C., and Backman, B. titled Teaching Oral Hygiene to Children with Autism(18). And was published in the International Journal of Pediatric Dentistry in 2005.

Instruments and Indices

An examination kit (mirror and probe) was used during clinical examination to assess and measure the plaque and gingival indices according to Silness and Loe Index (1964) (Appendix V). In addition, the initial DMFT [Who 1997] scores at baseline were recorded.

The plaque index of Silness and Löe, (1964) (19) was used to estimate the level of oral hygiene status by measuring plaque accumulation on the tooth surface. For illumination, both the light from the dental chair and the natural light were used. The following six representative teeth (Ramford teeth) were chosen for this purpose: (Teeth #3, 9, 12, 19, 25, 28 using the universal system, or 16, 21, 24, 36, 41, 44 using the FDI system) and their counter part in primary dentition (teeth # A, F, I, K, P, S using the universal system, or 55, 61, 64, 75, 81, 84 using the FDI system).

Since the Ramford teeth represented the permanent dentition only, and this study included both primary and permanent dentitions, a consultation was done with 3 members of the American Dental Hygienist Association whom advised us to use the counter teeth for the Ramford teeth in the primary dentition. Moreover, if any of the pre-selected numbered teeth were missing the adjacent tooth was scored.

Clinical Examination

The examiner used disposable mouth mirrors and probes for the inspection of the teeth surfaces. First the gingival index was recorded followed by the plaque index on special formulated charts (Appendix VI). Afterwards, the DMFT scores were recorded. These data were taken by the examiner only. A hygienist helped in transferring these numbers into the

PI and GI score charts. In order to calibrate these scores, the examiner had three training sessions before the actual start of the study. The examinations consisted of:

1- A base line examination.

2- 1st re-evaluation examination after 2 months from the base line exam.

3- 2nd re-evaluation examination 3 months after the 1st-re-evaluation.

After all examinations, each child was given a manual tooth brush (Colgate, soft) and toothpaste (Crest), brushing charts, and a reward of his choice from a gift box. A profile photograph was taken for the child only at the base line examination.

Tooth brushing program and PECS Cards

Each child/parent was given two sets of pictures (Appendix VII). The first set consisted of ten laminated small picture series developed by PECS to be hanged on a cartoon board by Velcro ® at home next to the sink in the bathroom or wherever the child might brush his or her teeth. The second set of pictures was identical to the first one. However, it was of larger size and written instructions were included on each picture card to be used as a single card. This set was to be used on a daily basis at home or at the center. One of the goals was to have the child learning a single card per day and to perform the required action set on the picture. Both groups of pictures were placed in a sequence demonstrating the systemic brushing of all teeth and tooth surfaces, i.e. the occlusal, buccal and lingual surfaces on the right and left hand sides for both the maxillary and the mandibular teeth. Whether their children used PECS, using PECS or did not use PECS before, all parents of the autistic children were given a detailed information on how to use them. A group

session was held to teach the parents the steps of PECS using a power point presentation, and models. And reinforcement session was given to each parent or caregiver at the clinical examination at the dental clinic and at the autism center.

The Picture Exchange Communication System PECS cards are originally in English. However to make it more adaptable to our region an Arabic version of PECS was produced with the permission of the publisher Mayer Johnson “PECS 4 Autism”.

Results

Participants in this study were solicited by distributing consent forms and cover letters to parents/guardians or direct caregivers of students from two different venues: an after school support group for children with autism spectrum disorder (ASD), and a private autism center. The consent was signed and returned by parents of 43 children out of the original 75 invitations that were sent to parents with autistic children to participate in this study yielding an initial response rate of 57.3%. However, 6 children did not continue the program for different reasons resulting in a final total of 37 children with autism taking part in the study equating a final participating rate of 38%. The study period lasted for 6 months between April and September of 2010.

Frequencies of the first set of questionnaires

4.1.1 Sample (Age and Gender)

Thirty seven (31 male and 6 female) children diagnosed with autism and/ or Autism Spectrum Disorder participated in the study. The age of the participants was divided into three groups: Group 1: children 3 to 6 years old, Group 2: children 7 to 12 years old, and Group 3: children 13 to 18 years old. Table (4.1.1) shows the distribution of children according to their age. Eleven children (29.7%) were between 3 and 6 years old, sixteen children between 7 and 12 years old, and ten children (27%) aged 13 to 18 years old.

The study included 31 male children a total of 83.8% of the participants, while only 6 female children participated in the study constituting 16.2% of the total sample. This resulted in a 5:1 ratio between males and females.

Table 4.1.1: Frequency distribution of age and gender variables among study population.

Variable	Total N (%)
Age (years)	
3-6	11(29.7)
7-12	16(43.2)
13-18	10(27.0)
Total N (%)	37(100.0)
Gender	
Male	31(83.8)
Female	6(16.2)
Total N (%)	37(100.0)

4.1.2 Diagnosis history

The history of diagnosis included: the age when the child was first diagnosed, and by whom he or she was first diagnosed.

For the purpose of this study, the age of 3 years was set to be the cut of age for the diagnosis of autism or autism spectrum disorder in these children. Table (4.1.2) shows that 22 children were aged 3 or older when they were diagnosed (59.5%), while 15 children were diagnosed under the age of 3 (40.5%).

Parents or caregivers were asked to answer the question about who provided them with this diagnosis. The results in table (4.1.2) show that only 2 children out of the 37 were diagnosed by school personnel, while 35 children were diagnosed by doctors (94.5%).

Table 4.1.2: Frequency distribution of autism diagnosis

Variable	Total N (%)
The age of diagnosis (years)	
≥ 3	22(59.5)
<3	15(40.5)
Total N (%)	37(100.0)
Child diagnosed by	
School personnel	2(5.4)
Doctor	35(94.6)
Total N (%)	37(100.0)

4.1.3 Child's Communication Method

Table (4.1.3) shows that 24 children (64.9%) with autism had some form of spoken language while 13 children (35.1%) had no spoken language. Among the 13 children who did not have any spoken language, parents and/or caregiver were asked about the method that their children communicate. Table (4.1.3) displays the different means in which these children communicate. Amongst which signals, sounds and hand-holding were the most used.

Table 4.1.3: Frequency distribution of oral language in children with autism

Child has oral language	Total N (%)
Yes	24(64.9)
No	13(35.1)
Signals	3(8.1)
Yell	1(2.7)
Depends on others	1(2.7)
Pushing	1(2.7)
Taking hands and pointing	1(2.7)
By pictures and body language or signals	2(5.4)
Signals , sounds and hand holding	3(8.1)
PECS , taking hands and signals (some time)	1(2.7)
Total N (%)	37(100.0)

4.1.4: Using PECS

To evaluate the knowledge and experience of both the parents and caregivers in PECS at the start of this experiment, the researcher wanted to know if the child had used PECS for any function, including dental hygiene, before the study or not. For those children who had used PECS, the question was how long they used PECS for. Table (4.1.4) reveals that 12 children (32.4%) have not learned to use PECS before the study. On the other hand, 25 children had used PECS before entering the study. Among these 25 children; 9 used it for less than 2 years, 2 had use it for a period of 2-3 years, 9 had used it for 3-4 years, and 5 had used PECS for a period of more than five years.

Table 4.1.4: Frequency distribution of PECS usage

Child has learned to use PECS before the study	Total N (%)
No	12(32.4)
Yes	25(67.6)
If Yes, How long did he or she used it for	
<2 years	9(24.3)
2 – 3years	2(5.4)
3-4 years	9(24.3)
> 4 years	5(13.5)
Total N (%)	37(100.0)

4.1.5 Child's dentist visits

Parents and caregivers were asked about the child's dental history in terms of regular dental visits, or lack of. They were also asked if their child had any professional teeth cleaning prior to the study. The results in table (4.1.5) showed that a large percent of children (83.8%) did not have regular check ups with their dentist, while only 16.2 % of children had regular check ups. Moreover, only 16 children out of the 37 had professional cleaning before starting the study.

Table 4.1.5: Frequency distribution of history child's dental visits

Variable	Total N (%)
Regular dental check up	
No	31(83.8)
Yes (within 6 months)	6(16.2)
Total N (%)	37(100.0)
Child never been to a dentist for teeth cleaning	
Yes	16(43.2)
No	21(56.8)
Total N (%)	37(100.0)

4.1.6 Tooth-brushing and Flossing

Tooth-brushing and flossing history is displayed in table (4.1.6). In addition, parents and caregivers were asked if the child brushes his or her teeth by himself, and what type of tooth-brush they were using. The results in table (4.1.6) showed that while 100% of participants claimed that they brush their teeth at least once daily, none of the participants used floss in their oral hygiene regimen.

The results revealed that 22 children needed help in brushing their teeth, while the other 15 brushed their teeth by themselves. Among the 37 participants, only 6 used an electric brush, while 31 used manual toothbrushes.

Table 4.1.6: Frequency distribution of tooth brushing and flossing history

Child brush his/her teeth by themselves	Total N (%)
Yes	15(40.5)
No	22(59.5)
Total N (%)	37(100.0)
Frequency of tooth brushing (time/day)	
Once daily	4(10.8)
2-3 times daily	33(89.2)
Total N (%)	37(100.0)
Child floss his/her teeth	
No	37(100.0)
Type of tooth brush	
Manual	31(83.8)
Electric	6(16.2)
Total N (%)	37(100.0)

4.1.6.A Relationship between GI and PI at baseline and ability to brush his/her teeth by themselves

This table compared the gingival and plaque scores at baseline and the ability of the participant to brush his or her teeth by themselves or if they had help doing so. The results showed that there was no significant difference between the two groups. Children who had help brushing their teeth did not have an advantage over those who brushed by them selves.

Table 4.1.6.A : Relationship between GI and PI at baseline and children brushing their teeth by themselves (N=37)

	Child brush his/her teeth by themselves			P value (χ^2-test)
GI at base line	Yes	No	Total (N%)	
Mild	5(13.5)	8(21.6)	13(35.1)	
Moderate	10(27.0)	14(37.8)	24(64.9)	
Total (N%)	15(40.5)	22(59.5)	37(100.0)	1.000
PI at base line				
Moderate	6(16.2)	13(35.1)	19(51.4)	
Abundant	9(24.3)	9(24.3)	18(48.6)	
Total	15(40.5)	22(59.5)	37(100.0)	0.325

4.1.6.B Relationship between GI and PI at baseline and frequency of tooth brushing

The results in table 4.1.6.B showed that the frequency of tooth brushing either once or more daily did not have a significant relation over the gingival and plaque indices at the baseline in the group of children with autism.

Table 4.1.6.B: Relationship between GI and PI at baseline and frequency of tooth brushing

	Frequency of tooth brushing (time/day)			P value (χ^2-test)
GI at base line	Once	2-3	Total (N%)	
Mild	1(2.7)	12(32.4)	13(35.1)	
Moderate	3(8.1)	21(56.8)	24(64.9)	
Total (N%)	4(10.8)	33(89.2)	37(100.0)	1.000
PI at base line				
Moderate	2(5.4)	17(45.9)	19(51.4)	
Abundant	2(5.4)	16(43.2)	18(48.6)	
Total	4(10.8)	33(89.2)	37(100.0)	1.000

4.1.6.C Relationship between GI and PI at base line and type of tooth brush used

Using an electrical tooth brush by children with autism did not have a significant difference over the manual tooth brush in this study in terms of the gingival and plaque scores at the base line.

Table 4.1.6.C: Relationship between GI and PI at base line and type of tooth brush used

	Type of tooth brush			P value
	Manual	*Electric*	*Total (N%)*	**(χ^2-test)**
GI at base line				
Mild	11(29.7)	2(5.4)	13(35.1)	
Moderate	20(54.1)	4(10.8)	24(64.9)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	1.000
PI at base line				
Moderate	16(43.2)	3(8.1)	19(51.4)	
Abundant	15(40.5)	3(8.1)	18(48.6)	
Total	31(83.8)	6(16.2)	37(100.0)	1.000

4.2 Frequencies of compliance with the program

The second set of questionnaires was distributed during a follow up after two weeks from the start of the study. After 6 children from the initial recruitment dropped out, 100% compliance was observed from the 37 remaining participants after two weeks. Table (4.2) indicates that 27 children used both sets of PECS (set hung on a cardboard, and single cards), and 10 used only one set of PECS (set hung on a cardboard). All 37 who used the first set of PECS hung it in the bathroom where they brushed their teeth.

At this time parents or caregivers were asked to grade the level of difficulty in using PECS as a method of teaching oral hygiene. Difficulty levels were divided into three categories: easy, hard, and very hard. Results from table (4.2) showed that most parents and caregiver rated the experience to be hard after two weeks. Only 3 parents or caregiver rated it easy, while 6 parents/caregivers rated it very hard. However, 100% of parents and caregiver said that PECS was a helpful tool, and that they will continue using PECS.

Table 4.2: Frequency distribution of using PECS program data among autistic children (N=37)

Variable	**Total N (%)**
Using PECS program by child	
Yes	37(100.0)
Using both sets of PECS	
Yes	27(73.0)
No	10(27.0)
Total N (%)	37(100.0)
Place where hanging the card board	
Bathroom	37(100.0)
Difficulty rate	
Easy	3(8.1)
Hard	28(75.7)
Very hard	6(16.2)
Total N (%)	37(100.0)
PECS a helpful tool	
Yes	37(100.0)
Going to continue using PECS	
Yes	37(100.0)

4.3 Oral Health

4.3.1 Gingival index average

Gingival index was measured at three different occasions within the 6 months period in which the study was conducted. The readings were recorded at: baseline, 1st reevaluation, and 2nd reevaluation. Table (4.3.1) shows that the mean baseline gingival index was 1.19±0.23, the mean gingival index at the 1st evaluation was 0.93±0.24, and the mean gingival index at the 2nd evaluation was 0.91±0.23. The difference between the baseline reading with both the 1st and 2nd reevaluations showed a highly significant difference in the gingival index with P value = 0.000. However, the results indicated that there was no significant difference in the gingival index score between the 1st and 2nd reevaluations with a P value = 0.027.

Table 4.3.1: Gingival index average at base line, 1st and 2nd re-evaluation visits, and the differences between visits among the study sample (N=37)

Mean ± SD Base line	Mean ± SD 1st re-eval	Mean ± SD 2nd re-eval	Difference 1 Base line – 1st re-eval	Difference 2 base line – 2nd re-eval	Difference 3 1st – 2nd re-eval
1.19±0.23	0.93±0.24	0.91±0.23	0.26* t=8.1 Z =-4.925	0.29* t=8.6 Z=-4.996	0.027NS t=1.8 Z =-1.732

* (P value =0.000), NS: Not Significant (P=0.083)

Paired t test (t)

Wilcoxon signed rank test (Z)

4.3.2 Plaque index average

Similarly, the plaque index was measured at three different occasions within the 6 months period in which the study was conducted. The readings were recorded at: baseline, 1st reevaluation, and 2nd reevaluation. Table (4.3.2) suggests that the plaque index scores had a highly significant difference between the baseline with both 1st and 2nd reevaluations and between the 1st and 2nd reevaluation as well.

Table 4.3.2: Plaque index average at base line, 1st and 2nd re-evaluation visits, and the differences between visits among the study sample (N=37)

Mean ± SD Base line	Mean ± SD 1st re-eval	Mean ± SD 2nd re-eval	Difference 1Base line –1st re-eval	Difference 2 base line – 2nd re-eval	Difference 3 1st – 2nd re-eval
2.04±0.34	1.47±0.28	1.33±0.29	0.57* t=13.4 Z=-5.255	0.71* t=19.1 Z=-5.342	0.14* t=4.5 Z=-3.828

* (P value =0.000)

Paired t test (t)

Wilcoxon signed rank test (Z)

4.3.3 Gingival index distribution in each visit

Table (4.3.3) shows the frequency of the severity of gingivitis in three different categories: mild, moderate, and severe.

The results at baseline for gingivitis showed that 13 children had mild gingivitis (35.1%) and 24 children presented with moderate gingivitis (64.9%). At the 1st reevaluation, the number of children who had mild gingivitis increased to 27 (73%), while diagnosis with

moderate gingivitis dropped to 10 children. This pattern continued at the 2nd reevaluation where the number of children with mild gingivitis increased to 31 leaving only 6 children with the diagnosis of moderate gingivitis. No severe gingivitis score was issued to any participant.

Table 4.3.3: Frequency distribution of GI at base line, 1st and 2nd re –evaluation visits among autistic children (N=37)

Variable	Total N (%)
GI at base line	
Mild	13(35.1)
Moderate	24(64.9)
GI at 1st re-evaluation visit	
Mild	27(73.0)
Moderate	10(27.0)
GI at 2nd re-evaluation visit	
Mild	31(83.8)
Moderate	6(16.2)

4.3.4 Plaque index distribution in each visit

Table (4.3.4) shows the frequency of plaque severity in three different categories: minimal, moderate, and abundant.

The results showed that at baseline 19 children (51.4%) experienced moderate plaque, while 18 children (48.6%) suffered abundant plaque accumulation. At the 1st reevaluation visit the majority of children (94.6%) had moderate plaque accumulation, no child had an abundant score of plaque, and only 2 children had minimal plaque accumulation. Similarly,

at the 2nd reevaluation no child showed an abundance of plaque accumulation. In addition, the number of children with minimal plaque scores slightly increased to 7 children, and a slight decrease was also observed in children with moderate accumulation.

Table 4.3.4: Frequency distribution of PI at base line, 1st and 2nd re –evaluation visits among autistic children (N=37)

PI at base line	
Moderate	19(51.4)
Abundant	18(48.6)
PI at 1st re-evaluation visit	
Minimal	2(5.4)
Moderate	35(94.6)
PI at 2nd re-evaluation visit	
Minimal	7(18.9)
Moderate	30(81.1)
Total N (%)	37(100.0)

4.3.5 Relationship between GI and PI at baseline and the DMFT index

The mean DMFT scores for the 37 patients with autism was calculated to be 3.78. Using this score as a reference and calculating the chi square, the results from table (4.3.5.A) show that there is a correlation between GI at baseline and the DMFT index. Similarly, when the relation between PI at baseline and the DMFT index was evaluated, the results in table (4.3.5.B) show that there is a significant difference thus a correlation between PI scores and the DMFT index.

Table 4.3.5.A: Relationship between GI at baseline and DMFT index. (N=37)

	DMFT index			P value
GI at base line	≤ (mean DMFT) 3.78	> (mean DMFT) 3.78	*Total (N%)*	**(χ^2-test)**
Mild	12(32.4)	1(2.7)	13(35.1)	
Moderate	8(21.6)	16(43.2)	24(64.9)	
Total (N%)	20(54.1)	17(45.9)	37(100.0)	0.001

Table 4.3.5.B: Relationship between PI at baseline and DMFT index. (N=37)

	DMFT index			P value
PI at base line	≤ (mean DMFT) 3.78	> (mean DMFT) 3.78	*Total (N%)*	**(χ^2-test)**
Moderate	14(37.8)	5(13.5)	19(51.4)	
Abundant	6(16.2)	12(32.4)	18(48.6)	
Total (N%)	20(54.1)	17(45.9)	37(100.0)	0.022

4.4 Comparisons

4.4.1 Comparison of gingival and plaque indices by gender

The results from table (4.5.1) show that at baseline about one third (32.3) of the male children had mild gingivitis and 2/3 of them (67.7%) had moderate gingivitis. At the same time, female children had equal frequencies for both mild and moderate gingivitis (50%). At the 1st reevaluation 22 male children and 5 female children had mild gingivitis, while 9 male children and 1 female child had moderate gingivitis. At the 2nd reevaluation no female child had a moderate score for gingivitis, and only 6 males had a score of moderate gingivitis. All six females had mild gingivitis, while 25 males had the same scores.

For the plaque index at baseline, the results show that 14 males and 5 females had moderate plaque accumulation, while 17 males and 1 female had abundant plaque accumulation. The 1st reevaluation resulted in 2 males with minimal plaque, and 29 males with moderate plaque. No females had minimal plaque accumulation at this visit. Similarly, all females at the 2nd reevaluation had moderate plaque, while the number of males with minimal plaque increased to 7, and the number of males with moderate plaque decreased to 24.

These results showed no significant difference between the two genders at each of the examination visits.

Table 4.4.1: Comparison of GI and PI at base line, 1st and 2nd re-evaluations visits among autistic children by gender. (N=37)

Variable	Male N(%)	Female N(%)	Total N(%)	P value (χ^2-test)
GI at base line				
Mild	10(27.0)	3(8.1)	13(35.1)	
Moderate	21(56.8)	3(8.1)	24(64.9)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	0.643
GI at 1st re-evaluation visit				
Mild	22(59.5)	5(13.5)	27(73.0)	
Moderate	9(24.3)	1(2.7)	10(27.0)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	1.000
GI at 2nd re-evaluation visit				
Mild	25(67.6)	6(16.2)	31(83.8)	
Moderate	6(16.2)	0(0.0)	6(16.2)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	0.561
PI at base line				
Moderate	14(37.8)	5(13.5)	19(51.4)	
Abundant	17(45.9)	1(2.7)	18(48.6)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	0.180
PI at 1st re-evaluation visit				
Minimal	2(5.4)	0(0.0)	2(5.4)	
Moderate	29(78.4)	6(16.2)	35(94.6)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	1.000
PI at 2nd re-evaluation visit				
Minimal	7(18.9)	0(0.0)	7(18.9)	
Moderate	24(64.9)	6(16.2)	30(81.1)	
Total (N%)	31(83.8)	6(16.2)	37(100.0)	0.571

4.4.2 Comparison of gingival and Plaque indices by age

Children with autism were divided into three groups according to their age: 3-6 years, 7-12 years, and 13-18 years.

Table (4.5.2) indicated that age was a significant difference in all gingival and plaque indices scores except in plaque index in the first reevaluation visit. The results also showed that children in the oldest group 13-18 had the highest gingival and plaque indices among all groups during all the three visits. Also, no child from the first two groups had a score for gingivitis above mild by the 2nd reevaluation. In Addition, the oldest group (13-18) had no slight plaque scores in all of the visits.

Table 4.4.2: Comparison of GI and PI at base line, 1st and 2nd re-evaluations visits among autistic children by age. (N=37)

Variable	3-6 yrs N(%)	7-12 yrs N(%)	13-18 yrs N(%)	Total N(%)	P value (χ^2-test)
GI at base line					
Mild	6(16.2)	6(16.2)	1(2.7)	13(35.1)	
Moderate	5(13.5)	10(27.0)	9(24.3)	24(64.9)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.036
GI at 1st re-evaluation					
Mild	10(27.0)	14(37.8)	3(8.1)	27(73.0)	
Moderate	1(2.7)	2(5.4)	7(18.9)	10(27.0)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.002
GI at 2nd re-evaluation					
Mild	11(29.7)	16(43.2)	4(10.8)	31(83.8)	
Moderate	0(0.0)	0(0.0)	6(16.2)	6(16.2)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.000
PI at base line					
Moderate	9(24.3)	8(21.6)	2(5.4)	19(51.4)	
Abundant	2(5.4)	8(21.6)	8(21.6)	18(48.6)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.005
PI at 1st re-evaluation					
Slight	1(2.7)	1(2.7)	0(0.0)	2(5.4)	
Moderate	10(27.0)	15(40.5)	10(27.0)	35(94.6)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.368
PI at 2nd re-evaluation					
Slight	5(13.5)	2(5.4)	0(0.0)	7(18.9)	
Moderate	6(16.2)	14(37.8)	10(27.0)	30(81.1)	
Total N(%)	11(29.7)	16(43.2)	10(27.0)	37(100.0)	0.008

4.4.3 PECS prior usage or lack of, and how it affected the gingival and plaque indices

From earlier results there were 12 children who did not use PECS, while 25 did use PECS prior to the study. After both groups were given instructions for the use of specific oral hygiene PECS, the results from table (4.5.3) showed no significant difference between the group of children who used PECS before the introduction of the oral hygiene instructions by the investigator and those who did not use PECS prior to the study.

Table: 4.4.3: Comparison of GI and PI at 1st and 2nd re-evaluations visits among autistic children by PECS usage. (N=37)

Variable	No	Yes	Total	P value
	N(%)	N(%)	N(%)	(χ^2-test)
GI at 1st re-evaluation visit				
Mild	8(21.6)	19(51.4)	27(73.0)	
Moderate	4(10.8)	6(16.2)	10(27.0)	
Total N(%)	12(32.4)	25(67.6)	37(100.0)	0.696
GI at 2nd re-evaluation visit				
Mild	9(24.3)	22(59.5)	31(83.8)	
Moderate	3(8.1)	3(8.1)	6(16.2)	
Total N(%)	12(32.4)	25(67.6)	37(100.0)	0.367
PI at 1st re-evaluation visit				
Slight	0(0.0)	2(5.4)	2(5.4)	
Moderate	12(32.4)	23(62.2)	35(94.6)	
Total N(%)	12(32.4)	25(67.6)	37(100.0)	1.000
PI at 2nd re-evaluation visit				
Slight	3(8.1)	4(10.8)	7(18.9)	
Moderate	9(24.3)	21(56.8)	30(81.1)	
Total N(%)	12(32.4)	25(67.6)	37(100.0)	0.659

4.4.4 Relation between the rates of PECS difficulties with: age, gender, and earlier training in PECS

Difficulty with PECS was rated as: easy, hard, or very hard. According to the results in table (4.5.4) age was a significant factor in rating the PECS difficulty. Sixteen percent of the youngest group's (3-6 years old) parents and caregivers found that it was very hard to use PECS with their children, while none of the other two age group's parents or caregivers found PECS to be very had to use. On the other hand, no parents or caregivers from groups with children from 3-6 years old found PECS to be easy. For children aged from 7-12, and 13-18 years old most parents found PECS to be hard to use.

Gender, on the other hand, showed no significant differences in terms of the difficulty of using PECS. Table (4.5.4) showed that the overwhelming majority of males and females rated PECS very hard to use.

Earlier training in PECS showed a significant difference in rating the difficulty of the using PECS as oral hygiene instruction. The results showed that no parent/caregiver rated the PECS to be easy when the child had not used PECS before, and the majority of this group rated PECS to be hard. Although the majority of parents/caregivers with children who used PECS prior to the study rated PECS to be hard, 8.1% of them rated PECS to be easy.

Table 4.4.4: Comparison of rate of difficulty of PECS usage among autistic children by age, gender, and earlier training. (N=37)

Variable	Easy N(%)	Hard N(%)	Very hard N(%)	Total N(%)	P value (χ^2-test)
Age (years)					
3-6	0(0.0)	5(13.5)	6(16.2)	11(29.7)	
7-12	1(2.7)	15(40.5)	0(0.0)	16(43.2)	
13-18	2(5.4)	8(21.6)	0(0.0)	10(27.0)	
Total N(%)	3(8.1)	28(75.7)	6(16.2)	37(100.0)	0.000
Gender					
Male	2(5.4)	23(62.2)	6(16.2)	31(83.8)	
Female	1(2.7)	5(13.5)	0(0.0)	6(16.2)	
Total N(%)	3(8.1)	28(75.7)	6(16.2)	37(100.0)	0.394
The age of diagnosis					
≥ 3	3(8.1)	15(40.5)	4(10.8)	22(59.5)	
<3	0(0.0)	13(35.1)	2(5.4)	15(40.5)	
Total N(%)	3(8.1)	28(75.7)	6(16.2)	37(100.0)	0.595
Child learned to use PECS					
Yes	3(8.1)	20(54.1)	2(5.4)	25(67.6)	
No	0(0.0)	8(21.6)	4(10.8)	12(32.4)	
Total N(%)	3(8.1)	28(75.7)	6(16.2)	37(100.0)	0.031
Using both sets of PECS					
Yes	3(8.1)	24(64.9)	0(0.0)	27(73.0)	
No	0(0.0)	4(10.8)	6(16.2)	10(27.0)	
Total N(%)	3(8.1)	28(75.7)	6(16.2)	37(100.0)	0.000

4.5 Correlations

4.5.1 Correlation between gingival and plaque indices at the three visits

Using a non-parametric Spearman`s rho correlation coefficient for comparison among visits regarding plaque and gingival indices, the results from table (4.6.1) showed a moderate correlation between gingival and plaque indices at the three visits intervals; 0.628, 0.475, and 0.454, respectively for the baseline, 1st reevaluation, and 2nd reevaluation.

Table 4.5.1: Correlation between PI and GI at baseline, 1st and 2nd re-evaluation visits (N=37)

Variable	PI at baseline		PI at 1st re-eval		PI at 2nd re-eval	
	r^{SP}	P-value	r^{SP}	P-value	r^{SP}	r^{SP}
GI at base line	0.628**	0.000				
GI at 1st re-eval			0.475**	0.003		
GI at 2nd re-eval					0.454**	0.005

Sp: Spearman`s rho correlation coefficient

Chapter Five: Discussion

5.1 Study Design

Since studies of dental health and oral conditions in children with autism are rare in our region, this study was the first study to assess the improvement in oral hygiene for children and adolescents diagnosed with autism using the Picture Exchange Communication System (PECS) aiming for better oral health in these individuals.

Children diagnosed with autism not only suffer from the neurobiological aspect of the disease, in fact emotional and psychological components are of major concern in dealing with these children which makes clinical research yet more challenging.

Our study's design took these factors into consideration; however, no control group was present in the study. This investigation was a prospective interventional 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 six months.

The results form the present study show that PECS is a suitable method to teach children with autism oral hygiene, i.e how to brush their teeth. In addition, the structure of the study also fulfilled their need for routines and continuity.

5.2 Importance of Oral Health

It is well established that oral health has a significant impact on overall health and wellbeing [Lawrence et al, 2001](20). Studies have shown that children and adolescent's

health and oral health can be affected negatively from dental diseases such as caries. Sheiha

[2006](21) argued that untreated caries can cause pain and infection which can directly reduce the intake of foods causing deficiencies in body weight, growth, and height of young children. In addition, oral diseases involve populations with special needs as well, and children with disabilities may be less likely to receive needed dental care compared to other types of medical care (22)[Demattei et al, 2007].

Thus, our goal as pediatric dentists is to treat the oral health of children as a part of their overall health particularly in children with special needs. Because of the rapid increase in the prevalence of autism cases, and because it is of a paramount importance that all efforts be directed toward the prevention of oral disease in this group of individuals, it is the pediatric dentist's challenge to seek out patients with autism and be able to recognize the signs and symptoms for this disorder not only to refer for medical care, but also to perform appropriate dental treatments.

5.3 Discussion of the Results

5.3.1 Sample

The results indicated that of the 37 participants 31 were boys (83.8%), and 6 were girls (16.2%) with a ratio of 5:1. This result is in agreement with previous studies when autism prevalence was compared between the two genders where the literature typically suggests a ratio of 4:1 for classic autism and 9:1(23)[Marwick et al, 2005] for autism spectrum disorders. Ehler at al [1993](24), argued that in terms of sex prevalence in ASD, prevalence figures for presentation of ASD in boys and girls have consistently shown that ASD is more common in boys, and there is a significant preponderance of boys in more able individuals; with a ratio of 4:1 for classic autism. Likewise, Chris et al [2007](25) argued that more boys than girls are consistently found to be affected with ASDs regardless of the study, the year conducted, or the reported rate of prevalence, with male to

female ratio ranging from 2:1 to 6.5:1. The male to female ratio is even higher for high functioning autism ranging from 6:1 to as high as 15:1 (26)[Volkmar et al, 2005].

5.3.2 Diagnosis history

The results show that 22 children were at age 3 or older when they were diagnosed with autism or autism spectrum disorders while 15 children were under the age of 3 when diagnosed. Although our study did not focus on the distribution of age of diagnosis, the age 3 years old was chosen because it a cut of age of significance in autism diagnosis. Although some studies argued that an ASD displays its signs before the age of three [Filipek et al, 1999](27), an American national study in 2005 was done by David et al(28), 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 specified.

The majority of children with autism in this study were diagnosed by a physician while only 2 children were diagnosed by school personnel including the staff of the autism center. Ideally, a team of professionals, including: a psychologist, psychiatrist, neurologist, pediatrician, speech and language pathologist, and social worker carry out the assessment to diagnose autism(29) [Filipek at al, 1999].

5.3.3 Child's Communication Methods

In this study almost 65% of parents indicated that their autistic children had some form of oral language, however the number of words spoken or the clarity of the spoken language was not recorded. On the other hand, almost 35% of parents said that their children had no spoken language, and the most prevalent mean of communication was through signal, sounds, and pointing.

This result differs from other studies that showed less percentage of spoken language in children with autism. Mirenda et al [1989] (30), argued that a range of 50% of autistic people will never develop speech as means of communication. Likewise, Gillberg [1994] (31) stated that about 50% of children with autism do not achieve spoken language. Moreover, Werner et al [2005] (32) argued that approximately 25% to 30% of children with ASDs begin to say words but then stop speaking, often between the ages of 15 and 24 months. Beukelman and Mirenda [2005](33) argued that even individuals with autism who develop speech show some idiosyncratic characteristics including echolalia, repetitiveness, monotonous intonation, literalness of meaning and eccentric use of phrases or words.

The high percentage of children with autism who had spoken language in this study could have resulted from different factors including: age of the children, the attendance at an autism center, and probably the biased answer of parents.

5.3.4 Using PECS

Autistic individuals tend to be visual learners and will therefore respond better to visual supports rather than written or spoken words. Therefore, PECS was developed to help individuals quickly acquire a functional means of communication (14)[Bondy et al, 1994]. In order to evaluate the knowledge and experience of both the parents and caregivers on PECS, and to establish a baseline record of parents knowledge, this study wonted to assess whether the child had used PECS previously or had not. All parents and caregivers of children with autism were given thorough instructions about the use of PECS even if their child had used PECS before for any other daily activities. The results indicated that 12 children out of the 37 did not have PECS skills at baseline. However, this factor was not significant as discussed later in this chapter after the evaluation of the oral health of these children.

5.3.5 Dental Visits

Thirty one children out of the 37 did not have regular dental check ups. Although parents/caregivers were not asked the reason why, it appears from the literature that autistic children indeed received less oral care than their normal counter parts for different reasons. Haveman et al [1997](34) argued that although parents consistently reported dental care as one of the top needed services for their children with disabilities, they often were not successful in finding dentists who are capable and willing to provide oral care services for their children. The National Maternal and Child Oral Health Resources [2005](35) stated that over 13% of US children and adolescents ages 17 and under have a special health care need and are almost twice as likely to have unmet oral health care needs as their normal developing peers across all income levels. They argued that more than 20% of children and adolescents with special care need have conditions that create financial problems for their families [NMCOHR, 2005].

5.3.6 Tooth brushing and Flossing

Gaare et al [2005](36) stated that the improvement in gingival health is through tooth brushing, and that tooth brushing is the most commonly recommended and performed oral hygiene behavior in North America and is done ubiquitously in developed nations. In addition, tooth brushing is considered a primary mechanical means of removing large amounts of plaque to prevent oral disease, including gingivitis and dental caries, while maintaining dental aesthetics and preventing halitosis. Moreover, the authors argued that while the primary mechanism of action of tooth brushing is the mechanical removal of plaque, it is also used as a means of delivering chemotherapeutic agents via toothpaste. The adequacy in controlling plaque is considered sub-optimal in developed countries where tooth brushing is used as part of their routine oral health interventions, particularly in the gingival area, which is critical in preventing inflammation. In their review, the authors

reported that the average daily toothbrush cleaning of two minutes could remove only 50% of all plaque, and that factors affecting the efficacy of tooth brushing include the technique, frequency, duration, brush type and design, and the dentifrice used.

However for autistic individuals, learning and practicing oral hygiene behaviors is not easily assured. For people with autism social skills are not naturally acquired and will need direct teaching (37)[Visual support of Autism, 2010]. Repeated oral hygiene instructions, and the involvement of parents and care givers are of paramount importance in oral disease prevention.

The results in our study showed that while 100% of participants claimed that they brushed their teeth at least once daily, plaque and gingivitis scores were much higher at baseline than after using PECS. These results may indicate that the methods used by parents/caregivers or by children who brushed their teeth by themselves before using the PECS program were insufficient. In addition, the claim of parents that their children brushed 2-3 times daily could have been false reporting which explain the high plaque and gingivitis score at the base line examination. Whether it was age of the child, time spent, dexterity of the child, or type of toothbrush the scores of plaque and gingivitis seemed to highly improve after the implementation of PECS.

Although the use of manual or electric toothbrushes was not compared in their efficacy of removing plaque, no one method had been shown to be superior in the literature. In addition, it was concluded that the conscientious and correct application of a brushing method was more critical than use of any specific method(38) [Gaare et al, 2005].

It is hard to determine if flossing had a considerable role in plaque and gingivitis because no caregiver/parent used flossing as part of their child's oral hygiene. On the other hand, Berchier et al [2005](39) assessed through a comprehensive review of the literature the

adjunctive effect of both flossing and tooth brushing versus tooth brushing alone on plaque and gingivitis and found that studies did not show an additional benefit for flossing on plaque and clinical parameters of gingivitis.

5.4 Compliance with the program

Most parents/caregivers rated PECS for an oral hygiene program to be hard after two weeks of the start of the experiment. Age, gender, and previous exposure to PECS effects on this rating will be discussed in details later in this chapter. Despite the hard rating, all parents/caregivers agreed that PECS was a helpful tool, and that they would continue to use it. It was very hard to compare the compliance and parents/caregivers satisfaction with this study to other studies due to the lack of reporting and different circumstances in different studies.

5.5 Oral Health

Before discussing the results of this title a brief discussion about gingivitis the immune system should be explained.

Bimstien et al [1999](40) emphasized the need for prevention, early diagnosis and early treatment of periodontal diseases in children. The pediatric dentist is required to differentiate between pathologic processes and normal changes that take place in the periodontum with age in order to avoid erroneous diagnosis and unnecessary treatments. They added that the age-related tendency to develop gingivitis, that is evident in children and adolescents, may be related to changes in the bacterial composition of the dental plaque, the inflammatory cell response, hormonal changes, morphological differences, tooth eruption and shedding (41) [Bimstien at al, 1999].

For the purpose of this paper the gingivitis stages and developments, the relation between gingivitis and plaque, immune system, and autism will be discussed.

There are two primary categories of gingival diseases, each with numerous subgroups [World Workshop in Clinical Periodontics, 1999](42). First, Dental plaque-induced gingival diseases including: gingivitis associated with plaque only, gingival diseases modified by systemic factors, gingival diseases modified by medications, and gingival diseases modified by malnutrition. The second category is the non-plaque-induced gingival lesions. For the scope of this study we are going to be focused on the first category of gingivitis.

According to The Academy Report for the treatment of plaque induced gingivitis [2001],(43) the etiology, or cause, of plaque-induced gingivitis is bacterial plaque, which acts to initiate the body's host response. This, in turn, can lead to destruction of the gingival tissues, which may progress to destruction of the periodontal attachment apparatus.

Page [1986](44) stated that gingivitis is caused by substances derived from microbial plaque accumulating at or near the gingival sulcus; all other suspected local and systemic etiologic factors either enhance plaque accumulation or retention, or enhance the susceptibility of the gingival tissue to microbial attack. The author explained argued that bacteria involved in the etiology of gingivitis include specific species of Streptoccous, Fusobacterium, Aclinomyces, VeiUonella, and Treponema and possibly Bacteroides, Capnocytophaga, and Eikenella. The initial lesion is an acute inflammation characterized by a lymphoid cell infiltrate predominated by T lymphocytes, characteristic of lesions seen at sites of cell-mediated hypersensitivity reactions. As the clinical condition worsens, the established lesion predominated by B lymphocytes and plasma cells. However, established lesions may remain stable for indefinite periods of time, they may revert, or they may

progress. The author argued that periodontal destruction does not result from the conversion of a predominantly T-cell to a predominantly B cell lesion, but rather from episodes of acute inflammation. Gingivitis and the periodontal microflora differ in children and adults. Clinical signs of gingivitis either do not appear as plaque accumulates, or they are greatly delayed in children, and the inflammatory infiltrate consists mostly of T lymphocytes. The conversion to a B cell lesion does not appear to occur (44)[Page, 1986].

With immune system involvement in periodontal disease, Mathur et al [1997](45) reviewed the topic, and the author found that the adaptive immune system consists of humoral and cell-mediated immunity of which the T-lymphocytes are the key components. In addition, CD4+ helper T-lymphocytes facilitate B-cells to differentiate and produce specific antibodies, whereas CD8+ cytotoxic T-lymphocytes kill virally infected cells. When periodontal disease appears, a variety of imbalances in the regulation of immune responses occur. These imbalances cause changes in the ratios of peripheral blood CD4+ and CD8+ T-lymphocytes, depressing proliferative responses of peripheral blood lymphocytes, and increasing the frequency of CD45RO+ memory T-lymphocytes in the diseased tissues. These changes have been reported in individuals with various forms of periodontal disease. They continue to say that the prominence of a particular subset of helper T-cells within the periodontal lesion could be a reflection of the stage and activity of the disease, or the types of bacteria present, however, longitudinal studies of the involvement of T-cell subsets and cytokines in periodontal disease are clearly needed [Mathur et al, 1997](45). Since gingivitis is related to the immune system response, it is worthwhile to study the relation between autism and the immune system in autistic individuals and its relation with gingivitis.

A new study by researchers at the University of California, Davis, MIND Institute and the NIEHS Center for Children's Environmental Health [2005](46) showed that children with

autism have different immune system responses than non-autistic children. Blood samples were taken from 30 autistic children and 26 normal children aged between 2 and 5 years old, and immune cells were isolated. The cells from both groups were then exposed to bacterial and viral agents that usually provoke T-cells, B cells and macrophages which are primary players in the immune system. In response to bacteria, the authors reported lower levels of protein molecules called cytokines in the autistic children group. Cytokines function as mediators of the immune response, carrying messages between B, T and other immune cells. They stated that since Cytokines are known to affect mood and behavior, and while their specific role in the development of autism remains unclear, the potential connection is an intriguing area of research that warrants further investigation. This study is part of a larger effort to learn how changes in immune system response may make some children more susceptible to the harmful effects of environmental agents.

In another review, Ashwood et al [2006],(47) stated that in autistic children immune aberrations consistent with a dysregulated immune response included abnormal or skewed T helper cell type 1 (T_H1)/T_H2 cytokine profiles, decreased lymphocyte numbers, decreased T cell mitogen response, and the imbalance of serum immunoglobulin levels. More over, autism has been linked with autoimmunity and an association with immune-based genes including human leukocyte antigen (HLA)-DRB1 and complement C4 alleles described. The authors concluded that further research should be conducted because such aberrant immune activity during vulnerable and critical periods of neurodevelopment could participate in the generation of neurological dysfunction characteristic of ASD

Although gingivitis and autism involvement in immune response is well documented, there are no direct studies up to our knowledge that links the unique autism immune response to gingivitis in autistic individuals. On the other hand, studies on the prevalence of gingivitis and periodontal disease among autistic individual show more or equal periodontal

involvement 48[Shapira et al, [1989],49 Bimstien et al, [1999], 50 Murshid [2005], and 51Burtner [2008]].

5.5.1 Gingival and plaque Indices Averages

In this study, gingival and plaque indices were measured at three different occasions within the 6 months period in which the study was conducted in. The readings were recorded at: baseline, 1st reevaluation after 3 months, and 2nd reevaluation after 6 months. The results indicated that there was a significant difference between the gingivitis scores at base line and the 1st reevaluation; however, the gingivitis scores were not significant between the 1st and 2nd reevaluations. This could be due to the dramatic improvement between the baseline and the 1st reevaluation visit.

However, the results for plaque scores revealed a significant difference between both the baseline and 1st reevaluation visits and between the 1st and 2nd reevaluation visits.

These results could be explained according to Loe et al [1969] 52 as they indicated that gingival inflammation subsided within a week of adequate tooth cleaning to control plaque. This explains that while plaque index score can change daily, gingival healing will take more time given the frequency of tooth brushing to achieve good plaque control. Bosman et al [1977] 53reported that it takes 7 to 10 days for gingival inflammation to heal within the group who brushed their teeth at least once a day.

Thus, participants in this study or via their parents/caregivers could have brushed their teeth immediately before the examination or at least earlier on the day of the examination since they were aware of the examination date. This resulted in a significant difference for plaque scores reading in both reevaluations, while the gingiva required more time to heal

resulting in no significant finding between the 1st and 2nd reevaluation for the gingivitis score readings.

5.5.2 Gingival and Plaque Distribution at each visit

The results indicated that both gingival and plaque indices in term of severity decreased. The number of autistic children with mild gingivitis increased as the number of autistic children with moderate gingivitis decreased. At the same time no participant had an abundant score of plaque by the 1st reevaluation while the number of participant with slight and moderate plaque scores increased. This could be due to the fact that autistic children and their parents/caregivers at the baseline did not know the exact clinical examination so they did not care to brush their teeth or their children teeth. While on the 1st and 2nd reevaluation they were more aware of the procedure so they brushed their teeth.

These finding did not differ between children with autism and from the general population. Lowe and Lindemann [1985]54 studied a group of 20 autistic patients and compared them to 20 non-autistic aged matched controls and assessed their dental needs. They concluded that no statistically significant differences were found in the oral hygiene indices including plaque and gingivitis. They noted a need for oral hygiene instructions and additional training for patients to increase their motor skills to perform more effective cleaning. More recently, Murshid [2005]55 examined 20 autistic children with an average age of 9 years. Intra-oral assessment showed poor oral hygiene (80%) and generalized gingivitis. They concluded that the periodontal oral health status of the examined autistic children did not show statistically significant differences from the international groups reported in previous studies.

5.5.3 Relationship between GI and PI at baseline and DMFT index

Studies in literature show that caries rate in children with autism are comparable to these in the unaffected population of their peers. Fahlvik et al [2001]56 compared Swedish autistic children between the ages of 3 and 19 years with non autistic population and found that there were no differences overall in dental caries levels between autistic and non autistic children. Like wise, DeMattei et al, 200757 conducted an oral assessment on 39 children with an ASD and 16 children with other developmental disabilities and concluded that there was no significant different in caries rates between the two groups. Similarly, Cheen et al [2008]58 conducted a study on the caries experience of dental patients with autism spectrum disorder comparing 395 patients with ASD to 386 unaffected patients and found that people with ASD were more likely to be caries-free and had lower DMFT scores than their unaffected peers.

In this study the mean DMFT scores for the 37 patients with autism was calculated to be 3.78. The results showed that there is a significance difference between GI and PI at baseline and DMFT index.

The DMFT scores of our study are in agreement with previous studies in the literature. Murshid [2005]55 examined 20 autistic children with an average age of 9 years. The mean DMFT score for permanent teeth was 1.6 for male and 7.25 for female, and the mean DMFT score for primary teeth for males and females was 3.62 and 1.0, respectively. They concluded that oral health status of the examined autistic children did not show any statistically significant differences from the international groups reported in previous studies.

The DMFT scores were also shown to be similar between autistic individuals and non autistics. Lowe and Lindemann [1985]54 studied a group of 20 autistic patients and compared them to 20 non-autistic aged matched controls and assessed their dental needs.

In the primary dentition, the patients with ASD demonstrated a significantly higher caries rate (DMF) than the controls on the initial examination; however at the recall examination DMF values were comparable. In patients with a permanent dentition, both at the baseline and recall and for both groups, DMF values were not different. There was a need for oral hygiene instructions and additional training for patients to increase their motor skills to perform more effective cleaning [Lowe at al, 1985]54. In 1989 Shapira58 et al described the oral health and dental needs of autistic children and young adults. They reported that the behavior of patients with autistic syndrome makes delivery of oral hygiene and dental treatment a problem. In their study, the oral health and DMFT of two groups of patients with autism were evaluated: non-institutionalized children with a mean age of 11 and institutionalized adults with a mean age of 22. Institutionalized adults were found to have lower decayed, missing, and filled teeth (DMFT) scores than functionally independent non-institutionalized persons of the same age. While the autistic children in a day care facility had caries rate similar to that of their peer

5.6 Discussion of the comparisons results

5.6.1 Comparison of gingival and plaque indices by gender

The results showed no significant difference between the two genders at each of the examination visits. However, this result differs from two other studies where males had higher indices for either gingivitis or plaque. In a study by Zhang et al [2010]59, the authors investigated the prevalence and severity of gingivitis and plaque in a representative Chinese population of adults. The results showed that there was no significant difference between the GI in males and females, while the males' PI values were significantly higher than those of females. However, the previous study as noted was done on adults where this study consisted of children. In another study by Faruta et al [2010]60 on gingivitis in

young population, the authors concluded that young females had lower gingivitis than males. They attributed this finding to the suggestion that females had greater knowledge, a more positive attitude, a healthier lifestyle and higher level of oral health behaviors than males. Other factors that could have contributed to our results were the small number of females in our study, and the fact that other studies were conducted on healthy individuals who did not suffer from autism. No studies to our knowledge were done on autistic population to compare gingival and plaque indices in both genders.

5.6.2 Comparison of gingival and plaque indices by age

Children with autism were divided into three groups according to their age: 3-6 years, 7-12 years, and 13-18 years. The results indicated that age was a significant factor in all gingival and plaque indices scores except in plaque index in the first reevaluation visit. The results also showed that children in the oldest group 13-18 had the highest gingival and plaque indices among all groups during all three visits.

This finding is in agreement with other studies in the literature review. In 1989 Shapira58 et al evaluated the periodontal status of non-institutionalized autistic children and institutionalized young adults, and found that the latter group had severe periodontal problems; and almost half required periodontal surgery, in comparison with the younger group.

DeMattei et al, 200757 conducted an oral assessment on 39 children with an ASD and 16 children with other developmental disabilities, among conditions assessed were bacterial plaque, and gingivitis. They compared the results between younger autistic children in the group with older children, children who lived at home with children who lived in a residential school. They found that gingivitis was a significant factor in the oral health status of children with an ASD when comparing younger children to older children or

when comparing children with an ASD who lived with their parents to those who lived at a residential school. The result showed that children with an ASD displayed the following percentages for clinically visible conditions: plaque (85%), and gingivitis (62%), The authors argued that it was not surprising to find a significantly higher incidence of gingivitis in older children who lived at the residential school. They explained that heavy plaque accumulation and hormonal influences are likely explanations for the high occurrence of gingivitis in this group.

The fact that age is a significant difference in all gingival and plaque indices scores except in plaque index in the first reevaluation visit could be due to the awareness of the participant of the examination date were they could have brushed their teeth prior to the examination. The results could have also been affected due to the small sample size in each category which made the chi-square not predictable.

5.6.3 PECS prior usage or lack of and how it affected the gingival and plaque indices

Twelve children did not use PECS, while 25 did use PECS prior to the study. However, the results showed no significant difference between the group who used PECS before the introduction of the oral hygiene instructions by the investigator and those who did not use PECS before.

These results indicated that for oral health, PECS may be used for all children with autism whether they were taught before or taught at the dental office. This also gives the opportunity to motivate the pediatric dentist, hygienists, parents and caregiver to know how to educate children the brushing technique using PECS even as a first learning method. In addition, it will be hard now for anyone to give excuses saying they do not

know how to use PECS as a reason for not teaching children with autism to brush their teeth.

5.6.4 Relation between the rates of PECS difficulties with: age, gender, and earlier training in PECS

Although most parents and caregivers rated PECS to be hard, all of them used it and were satisfied as seen from earlier results. This finding is in agreement with the assertion of Bondy and Frost [1994, 1998], and finding from previous studies that children with autism acquire PECS in a short amount of time [Charlop-Christy et al. 2002]. Quill [1995]61 reasoned that this may be related to the use of pictures, which complement the visual learning style of autistic individuals. Mirenda [1985]62 claimed that pictures required a minimal response effort and symbolic ability on the part of participants that may explain acquisition of PECS by persons with different disabilities. Another factor may have been the transparency of the icons. In our study, we used colored photographs which resembled the real objects. This may have created a one to one correspondence between the object and the picture, and thus facilitated learning.

In this study, age of the child was a significant factor on rating PECS difficulty where the youngest group found it to be hard and very hard, older groups rated it between easy to hard. This result could be due to higher cognitive, and communication abilities in older children. However, the variation in age at the beginning of the study shows that the ability to perform tooth brushing did not simply increase with age. On the other hand, gender of the participants was not a significant factor.

In the previous section, we discussed that the prior usage of PECS did not affect the oral hygiene outcome in the participants; however, the rating for PECS difficulties differed between the two groups: the group with prior usage, and the first time user group. The result showed significant difference between the two groups. The group who did not have prior knowledge of PECS found it to be harder to use than those who had used it before. This should be expected since parents and caregivers whose children had prior knowledge and training would pick up oral hygiene instructions from PECS not only faster but also easier than those children who did not use PECS before.

These results agree with finding of Schwartz et al [1998] in a retrospective descriptive study in which they examined the effects of PECS on preschool autistic and pervasive developmental disorders not otherwise specified (PDD-NOS) children, and other developmental disabilities. The researchers assessed the rate of PECS acquisition on 31 children of ages ranging from 3 to 6 years who were attending a university affiliated preschool program over a period of four years. The authors noted that these children did not attend the program at the same time, and those children who did attend at the same time did not have the same level of PECS training. The training sessions took place in the children's classrooms and in accordance with the PECS training manual. The results indicated that within an average of fourteen months all 31 children learned to use all phases of PECS with adults and peers.

5.7 Correlation

5.7.1 Correlation between gingival and plaque indices at the three visits

The results showed a moderate correlation between gingival and plaque indices at the three visit intervals. This result is in agreement with previous studies as the relation between plaque and gingivitis is well established. In 1969, Theilade63 et al in a classical a

longitudinal clinical and bacteriological investigation on experimental gingivitis in man where eleven experimental subjects with previously excellent oral hygiene and healthy gingiva developed heavy accumulations of plaque and generalized mild gingivitis after 9–21 days without oral hygiene. However, when oral hygiene was reinstituted, the plaque in most areas disappeared in 1–2 days and after 7–11 days the plaque index for each subject was as low as before the experiment. Correspondingly, after 1–2 days most tooth surfaces only harbored the original sparse flora of gram-positive cocci and rods, and the gingival inflammation in an area usually disappeared one day after the plaque had been removed.

In 1978, Loesche64 et al conducted a study on the effect of plaque on the gingivitis score. The plaque flora was isolated from discrete dentogingival sites during a human gingivitis experiment and was analyzed as a function of the plaque score and of the gingivitis score. They concluded that proportional changes in the gingival plaque flora may uniquely contribute to the development of gingival inflammation.

Ratka-Krüger et al [1989]65 studied the effects of plaque on gingivitis in 345 pre-school children at four and five years of age. Scores for plaque, gingivitis as well as tooth loss, caries and fillings were recorded. They concluded that there was clearly a correlation between the degree of oral hygiene and caries and gingivitis; children of the five-year age group were more severely involved than the four-year olds.

In a recent study by Chambrone et al [2010]66 on the prevalence and severity of gingivitis among school children aged 7-14 years, 206 children were examined; 107 males and 99 females, and data collected included plaque index (PI), gingival index (GI), and clinical probing depth (cpd). Results showed that overall, male subjects presented statistically more dental plaque and more gingival inflammation than female subjects. The authors concluded that gingivitis severity around permanent teeth was directly linked to the amount of dental plaque deposits and to the presence of bleeding on probing.

3.6 Follow- up

After two weeks of the initial examination, a follow-up was made by telephone or via e-mail to ensure the participation of the parents and their children. In which the parents or caregivers were asked the second set of questionnaires mentioned earlier. The clinical follow up consisted of two additional exams, 1st re-evaluation done 2 months after the initial base line exam, and a 2nd re-evaluation 3 months after the 1st re-evaluation. During the entire study period, the parents were given the opportunities to ask questions on the program or any additional instructions. In this follow-up, Parents were asked questions from the second set of questionnaire to evaluate the success or failure of the program from their point of view and to report and assist their child progression and cooperation with the study.

3.7 Data processing and statistical analysis:

Data were entered into a personal computer and analyzed using the Statistical Package for Social Sciences (SPSS) software version 11.0 (SPSS®: Inc., Chicago, IL, USA). Frequency distribution means and standard deviations were calculated. Normality test was done for gingival and plaque indices for all visits and they were not normally distributed, so we used non-parametric two related samples (Wilcoxon signed rank test) and non-parametric Spearman`s rho correlation coefficient for comparison among visits regarding plaque and gingival indices. In addition, ordinal (categorical data) data were tested with chi square test. The level of significance was set at ($P \leq 0.05$).

Bullet points

The goals and objectives of this project include:

1. To teach children and adolescents diagnosed with autism how to brush their teeth using The Picture Exchange Communication System (PECS).
2. To examine the effectiveness of PECS training on the oral health in autistic children by using gingival and plaque indices.
3. To improve the oral health status of the autistic children by better oral hygiene procedures.
4. To educate parents of children with autism the importance of brushing and prevention of oral disease.

Significance of the Study

- Because of the rapid increase in the prevalence of autism cases both internationally and more particularly in our region, and because it is of a paramount importance that all efforts be directed toward the prevention of oral disease in this group of individuals, this study was conducted.
- Bondy et al, [1994] argued that the significance of the PECS philosophy is not the specific picture card, but rather the process by which non-verbal children are taught to use these cards.
- Children who use PECS build independent communication skills. At the same time, apparently as a by-product, many children also gain significant spoken language [Bondy et al, 1994].

- Over a period of time, the aim of this study is to train children with autism oral hygiene practices using PECS to eventually enable these children to independently brush their teeth the correct way without relying on either PECS or caregivers.
- This might help parents with a very busy schedule in one aspect of the daily life of caring after their autistic children.

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