BREAKING THE COMMUNICATION BARRIER:

THE IMPACT OF SIGN LANGUAGE TRANSLATOR APPLICATION AS A COMMUNICATION AID ON HEARING IMPAIRED CHILDREN DURING DENTAL TREATMENT.

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"BREAKING THE COMMUNICATION BARRIER: The impact of Sign Language Translator Application as a communication aid on Hearing Impaired children during Dental treatment."** is a bonafide and genuine research work carried out by me under the guidance of **Dr. M JAYANTHI MDS**, Professor and Head, Department of Paediatrics and Preventive Dentistry, Ragas Dental College and Hospital, Chennai.

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ABSTRACT

Background:

Hearing impaired children may have difficulties in communication while undergoing dental treatment. The strategies aimed at establishing a trustworthy relationship between the child and the dentist plays a key role in the successful practice of paediatric dentistry.

Aim:

To evaluate and compare the efficiency of the Indian sign language translator application with nonverbal communication and sign language interpreter in relieving anxiety and improving the behavior of the hearing impaired children during dental treatment.

Methodology:

71 hearing impaired children who required multiple dental treatment were included in the study for whom oral prophylaxis was done with nonverbal communication in the first visit. Further the study population was divided into three groups based on their treatment needs for whom sign language translator application and interpreter was used as a communication mode during the treatment procedure in the subsequent visits in a crossover manner. Group 1

included hearing impaired children requiring only restorative procedures, group 2 included hearing impaired children requiring either extraction or pulp therapy and group 3 included hearing impaired children requiring combination of treatment procedures. Each child's subjective (Facial image scale) and objective (Pulse rate) anxiety scores, Frankl's behavior ratings and independent observer's ratings in each session were recorded. Questionnaire assessing the child's perception and parental satisfaction were recorded at the end of the 3rd visit. The data for 71 hearing impaired children was compiled and subjected to statistical analysis.

Results:

The results showed that there was no significant difference in the distribution of males and females across the three groups ($P \leq 0.05$). There was a significant reduction in the anxiety scores based on pulse rate and facial image scale when sign language translator application and interpreter was used as a communication mode ($P \leq 0.05$). There was significant improvement in behavior with all the three modes of communication ($P \leq 0.05$). The observer's rating showed that 70.42% and 67.6% of the study population were very easily able to understand the instructions and communicate with the dentist with sign language interpreter and translator application respectively. 67.6% of hearing impaired children selected mobile translator application and 32.39% selected interpreter as their preferred mode of communication for their future dental appointments.

98.5% of the parents recommended the use of mobile translator application during the dental treatment procedure to communicate with their hearing impaired children.

Conclusion:

Sign language translator application had a positive impact on the hearing impaired children by reducing their anxiety and improving their behavior during the dental treatment which was found to be as efficient as an interpreter and better than nonverbal communication. The translator application is not meant to replace the interpreter, but can be used as an alternative aid. Thus, this study concludes that the sign language translator application can be used as an adjunct in the management of hearing impaired children in the dental operatory.

Key words:

Hearing impaired children, sign language, nonverbal communication, translator application, interpreter, anxiety and behavior.

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Introduction

INTRODUCTION

The main objective of managing pediatric patients is not only treating their chief complaint and relieving them from pain, but also support them to overcome their anxiety and fear for which an effective communication between the pediatric dentist and child is mandatory. Communication is a complex multisensory process which has an ability to listen, empathize, and ultimately establish a trusting dentist–patient relationship. It is a two-way process with verbal utterances and non-verbal cues. [1] Implementation of behavior management strategies aimed at reducing anxiety caused by dental treatment depends on effective communication which is compromised in children with sensory impairment, and it has been reported as the prime reason for oral health being the greatest unattended need of the disabled. [2]

Hearing impairment is the second most frequently occurring sensory disability which primarily influences communication. [3] Hearing impairment refers to a condition in which individuals are fully or partially unable to detect some frequencies of sound that are heard by normal people. [4] Data from the National sample survey organization has estimated that about 0.3 million children in the age group of 0 to 6 years have hearing impairment in India. Over 21,000 children are born deaf every year, which implies that one child per every 1000 live births is hearing impaired. [5] The hearing impaired are classified into

congenitally or adventitiously deaf based on time of hearing loss, and range from mild (not exceeding 40db) to profound (exceeding 90db) based on the degree of hearing loss. [6, 7]

Communication acts as a biggest barrier to access health care for children with hearing impairment as the health system does not meet their special needs for communication. The main barrier for hearing impaired to communicate is the attitude adopted by others. Isolation and lack of information caused by hearing deficiencies, especially if serious, may give rise to linguistic, cognitive, social and emotional development of the child. There is a wide range of factors affecting the hearing impaired, making it necessary to treat them in a personalized way that includes patient's age, when the impairment was acquired, severity of impairment, any associated problems, communication skills and preferences, family factors, education, etc. [8]

There are various supportive aids available that enables the hearing impaired to communicate in a normal way such as hearing aids, cochlear implants, video phone or relay, sign language interpreters, etc. In addition, the child adapts to various modes to communicate such as sign language, lip reading, fingerspelling, written information or combination. However, most of the techniques are either expensive or not readily available, few are not useful

because of the severity of hearing impairment and others are of the practical difficulties during dental treatment. [2]

Lip reading is practiced by most of the hearing impaired people. It involves recognizing lip patterns and requires more concentration, which is fully efficient when conditions are ideal with good visibility. But, in the dental clinic there may be obstacles such as the dentist face mask, poor lighting, wrong location and position of the speaker, homophones, use of technical terms and supine position of the patient in the dental chair. [8]

Sign language is a virtual gesture language which includes face, hands and arms. It has its own phonology, morphology syntax and grammar equivalent to oral language. Sign language is the sensible answer for communicating with hearing impaired which is used by the deaf people, hearing children of deaf parents, hearing parents of hearing impaired children and educators for deaf people. [9] Gestural communication develops at home which is a type of self-developed sign language or home sign language. Deaf children begin communication in school by use of home sign, and then later they are taught the national sign language. [10] Sign language is not universal and it varies from one country to another. There are many sign languages such as American Sign Language, British sign language, Indian sign language, etc. In India, the

national sign language is followed almost everywhere with Andhra Pradesh as an exception where local or regional sign language is followed. [11]

Lack of sign language training and awareness among health service staff and the shortage or absence of aids to communicate are the obstacles to adopt sign language as a prime mode of communication. Hence, Dentist normally rely on a third party to interpret. An interpreter may be professional, family member or caregiver. Since the parents are child's first interpreters, they can determine child's attitudes towards new experiences [8]. When the sign language interpreter is used, common mistakes are looking at the interpreter more than the patient and to talk about the patient to the third person with no direct communication with the child and possible misinterpretation.

There is no structured program to impart knowledge on how to manage these children. [12] The normal management protocol will not be appropriate for a deaf child. Routine tell-show-do technique and treatment under general anesthesia are commonly employed management methods. [13] Raymond Cadden had created the eight-sign method (Dentisign) to reduce anxiety levels during dental treatment. But these eight signs were not sufficient to communicate effectively with disabled children. [2] Shalini Chandrasekhar and Sujog Jain devised some signs and gestures related to dentistry and used them successfully to improve their behavior positively and also instilled a positive dental attitude among hearing

impaired children. [2, 11] Derelioglu and Yilmaz recommended to treat these children under general anesthesia as there is difficulty in communication. [14] Nunn suggested the use of some basic actions for management of deaf children. [15] Navanith Renahan formulated a novel approach which was abbreviated as "I stumbled" in which he suggested the use of models, pictures and rating scales for managing children with hearing disability. [13] The other method tried by the dentists is the usage of visual media including cartoon or sign language videos to educate and improve their oral hygiene. [16, 4, 17] Maryam Ahmadi designed and implemented software for teaching health related topics to the deaf students. [18] All the attempts made to improve the communication between the dentist and patient were commonly limited to interactions during the history taking or explaining the treatment plan, and in most cases, we fall short of a definite plan of action for chairside behavior management of these children. [13]

Mobile phones are ubiquitous in distribution all over the world being extremely versatile and function as personal computers, playing an important part in day to day life. Rate of usage of smartphones in India by children is 56.6 %, Owing to the increasing spread of mobile technologies throughout the world, the World Health Organization (WHO) has coined a new term: mobile Health (mHealth), a component of eHealth, and is defined as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices". The

potential scope of evolution of smartphones and its use in treatment of patients does not seem to have been fully exploited yet. [19] Many valuable attempts were made with the use of technology and computer advances in the recent years in order to improve the health care system. However there is paucity of information regarding use of smartphones in achieving a better communication with the hearing impaired people.

There are few mobile applications available in the google play store that translates text or speech to sign language such as the Mimix 3d, Prodeaf Translator, Hand Talk Translator, etc. But the disadvantage of these available applications is that they are based on foreign sign language which cannot be understood by children in India.

The research on Indian Sign Language linguistics and phonological studies is limited because of lack of linguistically annotated and well documented data on Indian Sign Language. So, there is a need to build an automation system which can generate signs corresponding to the ISL words which are used while communicating with deaf people. [20] The newly developed Indian sign language translator application (SANKET™) is an android application which is available in google play store. The animated character will interpret text or speech input in English and deliver real-time Indian sign language translations, enabling easier communication with deaf and hard of hearing community without having to know

sign language. The application also includes writing text using keyboard and conversion of emoticons into text or speech which can facilitate the deaf people to interact with hearing people. This application is not meant to replace sign language interpreters, rather to make every-day communication with the deaf and hard of hearing community more accessible.

This mobile application is an attempt to bridge the barrier between hearing impaired children and pediatric dentists which comprises of a two-way communication where both the dentist and the patient interacts with each other. It may also invoke many more attempts to fabricate a concrete protocol, ultimately to benefit deaf children. Thus, the present study aimed to evaluate the applicability of the newly developed Indian sign language translator application for communicating with speech and hearing impaired children to relieve their anxiety and improve their behavior during dental treatment.

Aims & Objectives

AIMS AND OBJECTIVES

- To assess the efficiency of the sign language translator application in communicating with the speech and hearing impaired children during the dental treatment procedure.
- To assess the effectiveness of the nonverbal communication, sign language translator mobile application, sign language interpreter as communication modes on the anxiety levels and the behavior of children with hearing and speech difficulties in the dental operatory.
- To evaluate and compare the effective mode of communication between the operating dentist and hearing impaired children during the dental treatment.
- To assess the perception and attitude of speech and hearing impaired children and their parents or care givers on the mode of communication during the dental treatment.

Review of Literature

REVIEW OF LITERATURE

Carl. J. Schnittjer And Alfred Hirshoren (1981)[21] conducted a study to assess the behavior problems in hearing impaired children and compare with previous study outcomes with the help of a behavior problem checklist. The study was conducted in 192 hearing impaired children (101 males and 91 females) between 3-17 years of age. The scale consisted of conduct, personality, inadequacy- immaturity and socialized delinquency scale. The conduct problem factor showed significant difference between the two groups; similarly significant difference was seen with respect to socialized delinquency factor and immaturity-inadequacy factor. No significant difference was noted between the genders with respect to personality problem factor. More than 15% of males among the whole population showed conduct problem and similar results were seen in respect to socialized delinquency factor in females. Personality problem factor ranked fourth in prevalence rate. Thus the authors conclude that males have more behavior problems compared to females.

Adrian Davis, Sally Hind (1999)[22] conducted a study to assess the cognitive, behavioral performance and quality of life in children with permanent childhood hearing impairment (PCHI) who use spoken english as their first language. A total 100 children with PCHI were included in the study from sample of 653. Hearing children and children with otitis media with effusion were

included as control. The children's cognitive and receptive language abilities were assessed using the British ability scale and a test for the reception of grammar psychometric tests. They observed that majority of the children with PCHI were able to produce a standard test. However, PCHI and transient otitis media with effusion considerably impacted child's behavior. Parents of these impairment found a significant effect of their behavior on family life. Hence, the authors concluded that the effects of this type of communication disorder are pervasive and far greater than specific language impairment. They added that the effect of these on family, quality of life and adequacy of family support need to be explored further to guide intervention to facilitate cognitive development and behavior

Champion J and Holt R (2000)[23] conducted a study to determine whether there are indications that hearing impaired children experience difficulties in accessing dental care and/or in receiving dental treatment. They carried out the study by means of a questionnaire. Parents of 84 children were contacted through the national deaf children's society and answers obtained through questionnaire. Eighty-two children (98%) visited dentist, nearly two-thirds (63%) have stated at least one problem in communication while receiving dental care, 70% reported at least one problem while communicating with the doctor, whereas 62% reported that dentist had worn mask while communicating with the child. Hence, the authors suggested that removing masks while talking,

reducing background noise and use of simple signs may improve communication with hearing impaired children

Hines J (2000)[24] conducted a national survey to establish the nature of communication problems experienced by hearing-impaired patients nationally, to identify the more common reasons for the problems and to examine possible practical steps for improving the situation. The survey was conducted by questionnaire and the sampling frame confined to hearing-impaired patients who had been in hospital during the previous three years. A total of 359 completed and valid questionnaires were returned, covering 165 hospitals in the UK. The results showed the inability of hospital staff to communicate effectively with hearing impaired patients and communication problems between hearing-impaired hospital patients and staff were widespread and the level of the problem varied between hospitals, between wards and between individuals. The major factor was inadequate training of both nurses and doctors in deaf awareness and the associated communication skills. Other significant factors included patients concealing their disability, pressure of work and poor communication between staff. The author suggests that appropriate training at all staff levels should eliminate a high proportion of these problems.

Al- Qahtani Z and Wyne AH (2004)[25] conducted a study on 218 female children of age 6-7 year and 11-12 year blind, deaf and mentally retarded to

determine the caries experience and oral hygiene status. They observed that all the 6-7year blind had caries with mean deft score of 6.38, whereas11-12 year children had a mean DMFT of 3.89. The authors added that 11-12year old blind children had good oral hygiene compared to 6-7 years. The 6-7 year and 11-12 year deaf children had a mean caries scores of 7.35 and 5.12 respectively. One fifth of 6-7 year deaf children and only 7% of 11-12 year had good oral hygiene. Caries incidence in 6-7 year mentally retarded had a mean dmft of 8.00 and 11-12 year DMFT score of 5.81. Only 3.1% of mentally retarded 6-7 year and none of the 11-12year old had good oral hygiene. Hence, the authors concluded that caries prevalence and experience as well as oral hygiene in all the three groups were very high.

Maha AISarheed, Raman Bedi et al (2006)[26] developed a pre-tested, self- administered questionnaire and conducted a study to determine differences in behavior and attitudes of dentists in Riyadh, Saudi Arabia, in providing orthodontic care for children who are sensory impaired. The questionnaire was sent to all dentists working in Riyadh to assess the following domains: personal characteristics of the dentists and their practices, provision of dental care for children who are visually-impaired and/or hearing-impaired and their attitude toward providing orthodontic care for these children. Attitudes were measured on two scales and the overall score of these two scales represented each respondent's attitude. The results showed that 30 percent of the dentists provided dental care

for children with visual impairment and 45.3 percent did for children with hearing impairment. The provision of orthodontic care was significantly affected by the country in which the dentists had received their dental training and by number of years they had been in practice. The authors concluded that patients with hearing impairment were more likely to receive dental and orthodontic care than patients with visual impairment. The authors recommend that measures to shape the attitudes of the dental professionals should be initiated at the undergraduate level along with global guidelines for provision of orthodontic treatment for patients with sensory impairment which in turn will benefit both the professionals and patients.

Ajami BA, Shabzendedar M, Rezay YA, Asgary M (2007)[27] conducted a study to assess the frequency and severity of oral diseases and treatment needs using WHO criteria of caries, periodontal diseases and malocclusion in selected population of children with disabilities. The authors recruited 1621 children in the age range of 5- 16 years from 13 special schools and examination done using mouth mirror, and explorer with adequate lighting. They observed that hearing impaired children had lower caries frequency than those with mentally retarded and visual impaired. On the other hand, poor oral hygiene and periodontal status was seen in mentally retarded patients than other two groups. Class I malocclusion was found in 57% of the children. Based on the results, the authors finally concluded that an epidemiological survey followed by

the implementation and evaluation of long term public health care plan for children and adolescents with disabilities is highly suggested.

Silvia San Bernardino Alsmark, Joaquin de Nova Garcia et al (2007)[8] in their review article discussed about basic rules and advice for communicating with the hearing- impaired. The authors have classified hearing impaired into three groups- lip readers, sign language users and those with hearing aids. A hearing-impaired child should be dealt in the dental clinic as an individual. Visits should be carefully programmed so that the child does not have to wait too long in the waiting room, thus avoiding excessive anxiety and fear. Once the child is in the dental chair, the dentist, assistant and parent should remain within the child's field of vision. The dental clinic team should be able to use non-verbal communication, with body language and facial expressions. Since the parents are the child's first interpreters, they can determine the child's attitude towards new experiences. It can be useful to note how the parents speak to their child, using language that is as similar as possible. When there is trust on the part of the parents and the child, the child can gradually be separated from the parents as they will no longer be so necessary. Remember that full visibility is essential for communication with the hearing-impaired child and so that the child can see what is going on around him or her. The hearing-impaired child is especially afraid of the unknown, so needs many explanations and demonstrations. The say – show – do technique can be altered for these patients to show – do, but this must

take into account the patient's age, degree of impairment, communication skills, etc. The modelling technique may be very useful, allowing the child's sibling or another child to be observed while in the dental chair or by watching videos. Another way of explaining dental procedures is to use posters, photographs and drawings Hearing-impaired children are not very tolerant of long dental procedures. Make them as short as possible. If the child usually uses sign language, the parents may act as interpreters. If the dentist cannot use SL, they will have to be present at all times in the clinic... It is recommended that dentists should learn at least the basic structure of sign language and some simple signs as well as using facial and body expressions. The authors conclude that each child is different, depending on education received, communication skills possessed, and family factors, existence of associated problems, age and degree of deafness. Thus, treatment of hearing impaired children in the dental clinic must be personalized.

Santhosh Kumar, Rushabh Jayesh Dagli et al (2008)[9] conducted a cross- sectional study designed to determine the oral hygiene levels and periodontal status and investigate the association between oral hygiene levels, sociodemographic, and the grade of hearing loss in a group of 127 children and adolescents age ranging from 5 to 23 years with hearing impairment studying at a special school in Udaipur, India. Oral hygiene status was assessed by the Simplified Oral Hygiene Index (OHI-S) of Greene and Vermillion and

periodontal status by the Community Periodontal Index. In addition to clinical data, sociodemographic and medical data were retrieved from the children's records and through interviews with the person in charge. The demographic variables considered were age, social (caste) and economic status, and educational background of parents along with the information regarding place of living. The only medical variable included was the degree of hearing loss which was measured using otoacoustic emission screeners. The results showed that the oral hygiene status of the study population was poor, with a prevalence rate of 24%, 64%, and 12% for good, fair, and poor components, respectively. Moreover, poorer oral hygiene in persons who were hearing impaired was associated with declining education of mother. The authors concluded that children with hearing impairment have poor oral hygiene and high levels of periodontal disease which may be due to lack of communication; hence, the authors suggest that appropriate oral health education should be tailored to the needs of these students with the support of their teachers and their parents.

Manish Jain, Anmol Mathur et al (2008)[28] assessed the prevalence of caries and treatment needs, using a cross sectional study design, in 127 children, in the age range of 5-22 years, with hearing impairment. Dentition status and treatment needs along with DMFT, DMFS, deft, defs were recorded based on type- 3 examination procedure. The authors observed that the mean DMFT was 2.61, 87.4% needs treatment, filling of one tooth surface was necessary for 79.5%

of children, pulp treatment in less than 7%. There was a high prevalence (83.92%) of decayed teeth, whereas only 7.14% subjects had filled teeth. A close association between age and filled teeth was observed with multiple regression analysis, whereas linear regression analysis age explains a variation of 32% and 25.4% for DMFT and deft respectively. As young people with hearing impairment had a high prevalence of dental caries, poor oral hygiene, the authors concluded that prevention based intervention programs are recommended for this special group and added that efforts must be made to encourage the parents of these children to improve their oral health.

Simon ENM, Matee MI, Scheutz F (2008)[29] in a cross sectional study on 179 male and 142 female aged between 7 and 22 years determined the caries and periodontal status and treatment needs of handicapped primary school pupils in Tanzania. Among the participants considered, 71% were deaf followed by 17.8% blind, 1.9% both deaf and blind, 8.7% mentally retarded, and 0.3% blind and mentally retarded. The authors observed that 12.8% had at least one decayed deciduous tooth, having mean dmfs score ranging from 0.25 to 3.24. Of these, the highest mean decayed surfaces were seen on deaf pupil, followed by mentally retarded and blind. Whereas, 10.3% had decayed permanent teeth and 9.7% had missing permanent teeth. Concerning the periodontal status, the authors observed that 73.5% of the studied group had bleeding of the gums, with blind having the highest mean bleeding index scores and about 82.8% of the pupil had calculus,

with highest mean scores again among blind. Hence, the authors concluded low caries prevalence among handicapped primary school pupils, but relatively high level of gingival bleeding and calculus. Regarding treatment needs, 23% required dental fillings and 82% scaling and polishing.

Barker et al (2009)[30] conducted a cohort study to predict the behavior problems in deaf and hearing children with respect to influence of language, attention and parent- child communication. The study was conducted among 188 families with hearing impaired children 97 families whose children came under the category of normal hearing. After scrutinisation 116 families for hearing impaired group and 69 for normal hearing group were selected. The language measure was done using RDLS and MacArthur- Bates communicative developmental inventor. Parent report measures included child behavior checklist and parenting stress index. The second day was devoted to videotaped tasks, psychosocial questionnaires and parental reports of quality of life. The authors concluded that the language delays leads to more behavior problems whereas the other two parameters did not have any relation with behavior problems

Kanika Avasthi, Kalpana Bansal et al (2011)[31] conducted a study to determine the prevalence of dental caries, gingivitis, malocclusion and traumatic injury to upper anterior teeth among 614 sensory impaired children in the age group of 5-16 years attending special schools in Delhi and Gurgaon. Oral

examination was done and the findings were recorded on a specially designed oral health assessment form. The results showed that the prevalence of dental caries was more in the deaf/mute children at 72.43% while in the blind it was 59.68%, gingivitis was more in the blind at 71.53%, than the deaf/mute at 49.65%. The prevalence of malocclusion was 58% in the deaf/mute, while in the blind it was 30.69% and for trauma it was almost doubles in the blind (44.28%) when compared with the deaf (24.48%).The authors conclude that prevalence of dental diseases especially dental caries and gingivitis is as high as that seen in the normal children (60-70%) and that there is a need for administration of proper and professional dental treatment in these children.

Padma K. Bhat, Bhumika Kamal Badiyani et al (2011)[32] conducted a study to find correlation between dermatoglyphic pattern and caries among 100 (50 having caries and 50 not having caries) deaf and mute children aged 6-16 years. Their fingerprints were recorded with duplicating ink and caries experience was clinically assessed by dmft/DMFT index. Dermatoglyphic patterns of all 10 palmar digits were recorded using Cummins and Midlo (1943) method. The results revealed statistical association between whorl patterns and loop patters in caries and caries free group ($P<0.001$). The frequency of whorls was found to be more in caries group and the frequency of loops more in caries free group. The authors conclude that Dermatoglyphics could be an appropriate method to explore the possibility of a non-invasive and an early predictor for dental caries and

hearing impairment in children so as to initiate the preventive oral health measures at an early age.

Suma G, Usha Mohan Das et al (2011)[33] conducted a survey on 76 hearing and speech impaired children, in the age range of 5- 18 years, to evaluate the oral health status and oral hygiene practices through a questionnaire regarding their oral hygiene practices, previous dental visit and oral health knowledge. The results showed that 61% of the children never visited the dentist, 82.89% and 17.11% of the children brushed their tooth once and twice daily, 90% of them are cared about their teeth, 42% are having dental caries, 35% of them are having gingivitis and 19% malocclusion. The authors stressed the need of implementation of preventive care through comprehensive health care programmes in this population to prevent dental caries and periodontal diseases.

Rajat K Singh, Kritika Murawat et al (2012)[6] discussed in their review article regarding the factors to be considered in providing optimal dental care for a deaf pediatric patient. The authors have classified deafness into three classes- congenitally deaf, adventitiously deaf and hard- of hearing. He also discussed about the difficulties in communication between the dentist and the child with varied degree of hearing disability, the role of parents on the child's psychological adjustment, the importance of first dental visit and the modifications made in the dental operatory while treating children with hearing impairment. The author

recommends the dentists to develop knowledge and to understand the complexity of each particular form of handicap and its characteristics, so that he will be able to plan more efficiently for satisfactory treatment.

Malee Arunakul, Yosvimol Kuphasuk et al (2012)[4] conducted a cross sectional study to evaluate the effectiveness of oral hygiene instruction media on periodontal health in hearing impaired children over a period of three months. 66 hearing impaired children in the age group of 6- 10 years were randomly divided into 4 groups by oral hygiene instruction media type: video presentation group, illustrated book group, both video presentation and illustrated book group and control group. Gingival index, gingival bleeding index and plaque index were recorded at baseline and at 3 months follow-up. The results showed that there was significant reduction from baseline in the mean values for gingival index, bleeding index and plaque index in all groups including the control group after three months. Hence the authors concluded that further studies have to be performed in order to determine what factors resulted in this reduction.

Jain M, Bharadwaj SP et al (2013)[34] assessed and compared the oral health status and treatment needs of institutionalized hearing impaired and blind people. They conducted a descriptive cross- sectional study among 498 people (297 hearing impaired and 201 blind), in the age range of 4 to 23 years. Clinical examination was carried out and data collected using World Health Organization

basic methods and form. The total mean DMFT and dft scores of hearing impaired and blind people were 1.77 and 0.27 respectively. On an overall, 32% were periodontally healthy, 32% had shallow pockets and 7% deeper pockets; higher percentage of blind (43%) were periodontally healthy than hearing impaired (24%). Hence, the authors concluded that the overall health status was poor in the hearing impaired than blind subjects.

Tippanart Vichayanrat and Waritorn Kositpumivate (2014)[35] conducted a study to determine dental caries status, oral hygiene, and oral health related behaviors among college student from Ratchasuda College, Thailand, and to explore the relationships between the various factors such as socioeconomic factors, hearing status and their oral health status. 83 normal hearing and 97 hearing impaired students completed a self-administered questionnaire with assistance of a sign language video to obtain personal and behavior information. The results showed that prevalence of caries were 53.6% and 50.6% among students with hearing impairment and normal hearing, respectively (p=0.354). After age stratification, the hearing impaired students aged 18-21 years had significantly less filled teeth (p=0.012), and those older than 21 years had less missing teeth due to caries than normal-hearing students (p=0.023). Poor oral hygiene was found in 51.8% and 42.2% of normal and hearing-impaired students, respectively (p=0.365). Caries status was significantly associated with maternal education level (OR 3.56; 95% CI: 1.52-8.32) and oral hygiene (OR 3.26; 95%

CI: 1.64-6.45). The authors concluded that Hearing impairment did not appear to affect the prevalence of these conditions compared to those with normal hearing. Oral health education tools need to be developed and utilized for both normal hearing and hearing impaired college students in Thailand.

Patcharaphol Samnieng (2014)[36] conducted a study by means of a questionnaire to determine whether there are indications that hearing- impaired patients experience difficulties in accessing dental care and/or in receiving dental treatment among two hundred four patients (92 male, 112 female, mean ages 39±7.5 years) who were contacted through the deaf foundation. The results showed that 87 percent of all patients who have a hearing impairment had visited a dentist. Three-fourth of all patients (77%) were reported to have at least one problem in communication while receiving dental care, this increased significantly as the severity of the hearing impairment increased. 62 percent reported that the dentist had worn a mask while communicating and 55% that there had been background noise in the surgery during appointments. The authors conclude that deaf patients in particular often fail to obtain needed care because of communication difficulties experienced in the treatment situation. The authors recommend that removing masks while talking, reducing background noise and learning to use simple signs may improve communication with hearing-impaired patients.

Ciger S and Akan S (2014)[37] conducted a study on Turkish population to determine the occlusal characteristics of deaf-mute individuals and its gender distribution among 213 deaf and mute individuals (155 boys and 58 girls) in the age range of 10-24 years (mean age of 16.37±2.53 years). They divided the obtained information into four groups; dental, interarch, intraarch, and miscellaneous data. The authors observed that 75% had a class I molar relationship, whereas 13% and 8% had class II and class III relationships respectively. Whereas, normal bite, deep bite and open bite were seen in 23.9%, 38.4%, and 23.4% respectively, 6% individuals has one or more congenitally missing teeth. Regarding aesthetics, 81% had shown satisfaction, whereas 19% expressed the contrary. Hence, the authors concluded that different characteristics and malocclusions are present in deaf- mute individuals.

Sandeep V, Vinay C et al (2014)[17] conducted a prospective triple blind interventional study to verify the impact of visual instruction on oral hygiene status of children with hearing impairment. Oral hygiene status of 372 institutionalized children (180 study group and 192 control group) aged 6-16 years, was evaluated using Loe and Silness Gingival index and Silness and Loe Plaque index. Motivation in the form of visual instruction was done in the study group every weekend for 12 weeks and control group was followed without motivation. After 12 weeks, Oral hygiene status was re-assessed and analyzed. The results showed that there was a reduction of plaque score (from 1.70 to 1.33,

mean- 0.37) and gingival score (from 1.59 to 1.2, mean- 0.39) in the study group, whereas there was reduction of plaque score (from 1.64 to 1.56, mean- 0.08) and gingival scores (from 1.63 to 1.53, mean- 0.1) observed in the control group, which showed significant differences ($p<0.001$) between the two groups. The authors concluded that visual instruction was found to be an effective oral health education tool in children with hearing impairment.

Vabitha Shetty, Jithendra Kumar et al (2014)[38] specially designed a visual oral health education (OHE) program for children with hearing Impairment and conducted a study to evaluate its efficacy in improving their oral health status after periods of reinforcement and no reinforcement. The study included a total number of 110 children with severe hearing impairment aged 6–14 years. Oral health status of all the children was recorded using a modified WHO Oral health assessment form (1997), Gingival Health Status was recorded using the Modified Gingival Index (MGI) given by Weatherford et al. (1986), Oral hygiene of the children was assessed using the Turesky-Gilmore-Glickman modification of the Quigley–Hein plaque index (1970) and Streptococcus mutants colony count of the children was also evaluated. Tooth brushing skills of the children were evaluated using the Simmons Brushing skills Index. An OHE talk was delivered with the help of the teachers and care providers, who used sign language to communicate. After a month of reinforced tooth brushing, all the children were subjected to a reevaluation. Further, all the children were subjected to a period of 2 months of no

reinforced tooth brushing. The results showed a highly significant ($p<0.001$) improvement in the gingival health of all the children from the pre-OHE to the end of the reinforcement period and a further similarly significant improvement at the end of the non-reinforcement period. Brushing skills of children improved significantly at the end of study, notably in areas where brushing was previously deemed unsatisfactory. Significant reduction in S. mutans counts were observed at the end of reinforcement period and further significant reduction at the end of period of non-reinforcement ($p<0.01$). The authors concluded that OHE program specially formulated for the hearing impaired children was effective in improving their oral health status significantly.

Sonia Pareek, Anup Nagaraj et al (2015)[39] conducted a single- blind, parallel- design, randomized controlled trial to evaluate the effectiveness of supervised tooth brushing in improving the plaque levels and gingival status for a period of 6 months in a school for hearing impaired and mute children in Jaipur. The study included 315 students who were divided into three groups of 105 children each. Group A included resident students, who underwent supervised tooth brushing under the supervision of their parents. The non‑resident students were further divided into two groups: Group B and Group C. Group B children were under the supervision of a caregiver and Group C children were under the supervision of both investigator and caregiver. The results showed that there was

an average reduction in plaque score during the subsequent second follow‑up conducted 3 weeks after the start of the study and in the final follow‑up conducted at 6 weeks. There was also a marked reduction in the gingival index scores in all the three groups. The authors conclude that the program of teacher and parent supervised tooth brushing with fluoride toothpaste can be safely targeted to socially deprived communities and can enable a significant reduction in plaque and gingival scores. They also recommend both comprehensive and incremental dental care for these subjects in special schools in order to improve their oral health with the cooperation of local dental institution, parents, school authorities, voluntary organizations and the government.

Maryam Ahmadi, Masoomeh Abbasi et al (2015)[18] performed a study to assess the possibility of implementing a health education software program in Tehran. They identified the priority health needs of deaf students in primary schools through interviewers with teachers in primary school. The training videos based on health care needs including health, dental, ear, nails and hair care aids, washing hands and face, corners of bathroom were recorded, edited and the required software was created in stages including the use of sign language, lip reading, pictures, animation and simple and short subtitles. The authors thus concluded that this software can be used to help teachers and student's families to educate and promote the health of deaf students.

Raluca Diana Suhani, Mihai Flaviu Suhani et al (2015)[40] conducted an epidemiological study to investigate the prevalence of deleterious oral habits among children with hearing impairment and comparing results against children without hearing impairment. A clinical examination was done for 150 children with hearing impairment and 165 without hearing impairment. The parents/legal guardians were asked to complete a questionnaire regarding the deleterious habits of their children. The results showed higher prevalence of deleterious oral habits among children with hearing impairment (53.3%) as opposed to (40.6%) among children without hearing impairment. Tongue thrust swallowing was found to be the most common habit in children with HI (20%), followed by mouth breathing (8.66%). There was a higher incidence of malocclusion in children with hearing impairment (79.3%) compared to children without hearing impairment (57%). The authors concluded that deleterious oral habits prevalence and malocclusion in hearing impaired children was higher compared to children without hearing impairment.

Liliya Doichinova and Milena Peneva (2015)[41] conducted training for deaf children on the principles of oral hygiene for a period of one year. This study included 100 children with hearing loss (61 boys and 39 girls) aged between 5 and 12 years. Demonstration materials, that included enlarged models of plaster teeth with and without carious destruction; red silicone imitation plaque and plaque-retentive places; foam glued to the teeth with cavities, imitating softening of the

tooth structure; art system presenting the rules for oral hygiene. Audio-visual materials – cartoons, created by Colgate, The American Dental Association and slide films of the French Union for oral and dental health, UFSBD. A special methodology for training in oral hygiene was used in accordance with the disabilities and psychological characteristics of the children with hearing loss. The results showed significant (<0.001) improvement in oral hygiene after six months of training. Thus the created training program in oral hygiene for children with hearing disabilities, supported by specially crafted picture training system provide a real opportunity to improve the oral environment and reduce the risk of caries.

Sandeep V, Manikya Kumar et al (2016)[42] conducted a descriptive cross‐sectional study to evaluate the oral health status and treatment needs of children with hearing impairment attending a special school in Bhimavaram Town, India. This study involved 180 CHI of both genders, aged 6–16 years, divided into Group‐I (6–8 years), Group‐II (9–12 years), and Group‐III (13–16 years). Oral health status and treatment needs were recorded using methods and standards recommended by the WHO for Oral Health Surveys, 1997. Dental caries prevalence (decayed, missing, and filled teeth [DMFT/dmft]), gingivitis levels (Löe, Silness Gingival Index), plaque levels (Silness, Löe Plaque index), and treatment needs were the parameters recorded and analyzed. The results

showed that Prevalence of dental caries in the sample was found to be 65% with a mean level of caries prevalence (DMFT) of 1.6 ± 1.3 in Group‑I, 1.9 ± 1.2 in Group‑II, and 2.2 ± 1.2 in Group‑III and (dmft) of 2.8 ± 2.2 in Group – I, 2.1 ± 1.5 in Group II and 1.1 ± 1.3 in Group III. About 91.7% of the total children examined needs treatment. The mean plaque and gingivitis scores of the sample were 1.70 ± 0.61 and 1.59 ± 0.58, respectively. Thus the authors conclude that children with hearing impairment have poor oral health and extensive treatment needs. They also suggested that oral health educational programs should be tailored to this important group to improve their oral health status.

Suhani RD, Suhani MF, Badea ME (2016)[43] did a cross sectional study on 165 deaf participants (mean age of 29.6), for assessing dental fear and anxiety among them. They employed a questionnaire containing three sections, first section contained questions based on social and economic status, second part contained a Romanian version of the modified dental anxiety scale and final part three was a dental fear survey. Based on modified dental anxiety scale scores, the authors observed that 34.9% were found to be insignificantly anxious, 59.7% moderately or extremely anxious and 5.3% identified with dental phobia. The mean total score for dental anxiety was 13.7 and the participants suffering from a prior negative experience were found to be more anxious. Hence, the authors concluded that dental fear and anxiety is prevalent in the deaf communities, and

added that higher percentage were observed among women and people with earlier bad dental experience.

Sudipta Kar, Goutam Kundu et al (2016)[44] conducted a cross-sectional, case-control study to evaluate and compare the prevalence of dental caries in hearing-impaired and normal children of Malda, West Bengal, utilizing the Caries Assessment Spectrum and Treatment (CAST). Dental caries status of 236 hearing-impaired children and 272 normal children were studied with an age group 6–12-year, using CAST, a recent caries assessment system. The results showed that the caries affected hearing-impaired children found about 30.51% compared to 15.81% in normal children, and the result was statistically significant ($P < 0.05$). Regarding individual caries assessment criteria, nearly all subgroups reflect statistically significant difference except sealed tooth structure group, internal caries-related discoloration in dentin, and distinct cavitation into dentine group. The authors conclude that the dental health of hearing-impaired children was found unsatisfactory than normal children when studied in relation to dental caries status evaluated with CAST

Avinash Jnaneswar, Goutham Bala Subramaniya et al (2017)[45] conducted a descriptive cross‑sectional study to assess the prevalence of dental caries and periodontal status of institutionalized hearing impaired (HI) children in Khordha district of Odisha. 540 children of age ranging from 5 to 15 years with

hearing impairment were assessed for caries and periodontal status with Type III examination procedure using WHO Oral Health Assessment form (1997). The results showed that bleeding on probing was found in 72 (13.3%) female children as compared to 57 (10.6%) male children. While 131 (24.3%) female children had calculus, 124 (23.0%) male children had the same condition. Total caries prevalence was 19.3%. Statistically highly significant difference was found for mean decayed teeth (DT), missing teeth decayed, missing filled teeth (FT) ($P < 0.001$), while for mean FT there was no statistically significant difference according to the age groups. Statistically highly significant difference was found for mean DT, extracted teeth and decayed, extracted, filled teeth ($P < 0.001$). The authors conclude that the findings in this study spotlight the lack of dental treatment for this group and an improved accessibility to dental services as well as dental health education is necessary to ensure the optimum dental health within the reach of these less fortunate children.

Navanith Renahan, Balagopal Varma et al (2017)[13] discussed about a definite plan of action for chairside behavior of children with hearing impairment and reported a case of a 6 year old child having class 3 deafness who was uncooperative and had a phobia towards medical practitioners. The authors devised two modes of management, first mode was sign language with actions and the second mode was using models, pictures and rating scales, they also formulated a novel strategy which was abbreviated as “I stumbled”, in which they

recommend the dentist to use images, models, desensitization techniques, learn sign language, stress on lip movement and be enthusiastic. The authors conclude that a well- constructed protocol will serve in the successful management of deaf children.

Gema Nazri Yanti, Rika Mayasari Alamsyah et al (2017)[16] conducted a clinical experimental study to know the effectiveness of dental health education using Cartoon video showing method on knowledge and oral hygiene of deaf student before, after and a week after dental health education. This study was conducted with 92 deaf children aged around 10-15 years. The dental health education using cartoon video showing method that use a sign language in such a way that it can be understood by the deaf children. Knowledge score was measured using questionnaire and oral hygiene score was measured using OHIS index. Initial knowledge and oral hygiene score measured at day 1 and then gave them dental health education using the cartoon video showing and training how to brush the tooth properly and measured again at day 2. Dental health education with cartoon video was played for a week before the class started, then measured again at day 8. The results showed that the level of the knowledge increased significantly (p=0.000) before education to after education and there was significant differences of oral hygiene score before, and a week after dental health education (p=0.000).The author concluded that dental health education using

cartoon video is effective in increasing knowledge and decreasing oral hygiene score in deaf children.

Suyog Jain, Vijay Duggi et al (2017)[11] conducted a study to bridge the gap between hearing impaired children and pediatric dentists. This study was carried out among 100 deaf children in the age group of 10-14 years. One dentist (expert dentist) was trained in the nonverbal communication and the other dentist (non expert dentist) had no knowledge of this type of communication, communicated the same sets of statements related to dentistry, to the hearing impaired children in two different special schools in two different states in India. One translator was assigned to judge their interactions. Students were asked to tell the interpreter at the end of each signed interaction what they understood from the statement conveyed to them by both the dentists. The non-expert dentist conveyed only 36.3% of the information correctly to the students, whereas the expert dentist conveyed 83% of the information correctly. Thus, the authors concluded that dentists should be made aware of the nonverbal communication, signs and gestures related to dentistry should be taught to the hearing impaired students as well as the dental students.

Kausar Sadia Fakhrudhin, Mehmet Omer Gorduysus et al (2017)[46] conducted a randomized crossover clinical study which aimed to assess the effectiveness of behavioral modification techniques in combination with visual

distraction with or without video eyewear using computerized delivery system-intrasulcular during the application of local anesthesia in hearing impaired pediatric patients undergoing pulp therapy of primary molars. The study comprised of 15 children divided into 2 groups (group a: 7, group b: 8) with mean age 6.1 years. During session 1, tell-show-do technique was employed, prophylactic dental cleaning was done while participants were watching a movie with sign language interpretation with visual eyewear for maxillary arch and without visual eyewear for mandibular arch. Anxiety assessment was done using smiley faces program. During session 2 and 3, both groups underwent pulp therapy with or without video eyewear and vice versa. After the procedure, children were instructed to rate their pain during treatment on the Wong-Bakers faces pain scale. Changes in pulse oximeter and heart rate were recorded every 5 minutes. The results showed that there was a significant change (>0.04) in the heart rate in group A, who underwent pulp therapy while watching video using video eyewear. Self-reported mean pain score for both groups increases during treatment with video eyewear. The study concludes that routine psychological (tell-show-do) intervention along with visual distraction with full visibility of the surrounding and use of CDS-IS system for anesthetic delivery is recommended as an effective behavior management technique for children with hearing impairment undergoing invasive dental treatment.

Amrita Sujlana, Ruchika Goyal et al (2017)[47] conducted a study to assess the effect of visual pedagogy and probiotic mouth rinse on the periodontal health of twenty hearing impaired children and twenty age-matched healthy children. The gingival index (GI), plaque index (PI), and salivary pH for all children were assessed at baseline, 15 days after oral hygiene training using visual pedagogy, 15 days after probiotic mouth rinse (1 g powder of 1.25 billion freeze dried bacterial combination of Lactobacillus rhamnosus, Bifidobacterium longum and Saccharromyces cerevisiae) introduction, and at the end of the test period, i.e., 2 months after discontinuing probiotics. The results showed that there was no significant improvement in GI and PI scores after oral hygiene training in either of the two groups. The use of probiotic mouth rinse significantly reduced GI scores (<0.01) and PI scores (<0.01) and increased salivary pH above the critical pH in both groups. The author concluded that the use of visual pedagogy coupled with probiotic mouth rinsing may improve the periodontal status of children with hearing impairment.

K. M. Shivakumar, Snehal Patil et al (2017)[48] conducted a cross-sectional survey to collect the primary data and to determine the oral hygiene status, dental caries levels, and periodontal status among 150 children aged 5–18 years sensory impaired children's of Satara district in western Maharashtra, India. The subjects were examined using Type III clinical examination. Oral hygiene

status by oral hygiene index‑simplified (OHI‑S), decayed, missing, and filled teeth/surface (DMFT/S) index, periodontal status by community periodontal index, and dentition status and treatment needs were assessed. The results showed that the highest component of DMFT/dmft was the decayed component, with a mean of 2.71 ± 1.92. The $P < 0.05$ was statistically significant. The Calculus Index‑Simplified and OHI‑S index showed a significant difference between males and females of the study population ($P < 0.05$, S). Of 150 subjects examined, 72.6% subjects needed one surface filling, while 21.3% needed two surface fillings, 15.3% needed pit and fissure sealant application, 10% needed pulp care, and 6% needed tooth extraction. The authors concluded that there is an alarming situation for dental diseases among special children. Hence, they recommend to encourage their parents and school teachers to promote and improve their dental health.

Shalini Chandrasekhar, Ghanashyam Prasad Madu et al (2017)[2] performed a randomized clinical trial which aimed to evaluate the applicability of dental sign language in hearing impaired children for relieving anxiety during dental treatment by improving their means of communication. The study comprised of 40 children who were equally divided into the study and control group, age ranged from 6-12 years. Children who had moderate to severe hearing impairment with moderate to poor oral health requiring restoration for a class I

dental lesion and with no previous dental experience were selected for the study. In the control group, oral prophylaxis and class I restorations were done without the explanation of the treatment procedure. During treatment, there were no means of communication used between the operating dentist and child. In the study group, 20 children were divided into groups of 10 each, for convenience to effectively educate dental sign language. The dental sign language specific to dental treatment was educated by trained professionals using visual aids. During their visit to the dental clinic, a quick review of dental sign language using the visual aids was given before the treatment, which acted as reinforcement. All treatment procedures and instructions to be followed were explained using the dental sign language by the operating dentist. During the procedure, use of dental sign language was repeated for giving instructions and also for reassurance to patients, which acted as a means of communication. Subjective and objective measurements of anxiety were recorded in both groups using electronic blood pressure apparatus, physiological parameters inclusive of the pulse oximeter and Facial image scale (FIS). By using the dental sign language, there was a significant reduction in anxiety levels as described by the parameters from the pre-treatment to post-treatment period in the study group ($p<0.05$). However in the control group, there was no significant difference in the anxiety levels from the pre-treatment to the post- treatment period. Thus, the authors conclude that

dental sign language proved to be effective in relieving the anxiety in hearing impaired children.

Raghavendra M. Shetty, Aditi Pashine et al (2018)[49] conducted a study to assess and compare the role of IQ on anxiety and behavior of children with and without hearing and speech impairment. Children of age group 7–14 years were included in the study, of which control group comprised of 60 normal healthy children and 60 hearing and speech impaired children formed the study group. The study was done in two consecutive sessions. First appointment for Culture Fair Intelligence Test and second appointment for RMS pictorial anxiety score (RMS-PS) and Frankl behavior rating which were assessed during oral prophylaxis. The results showed that IQ of children with hearing and speech impairment (66.6 ± 9.74) was lower as compared to normal healthy children (81.52 ± 13.9). There was a positive correlation ($p<0.001$) between IQ and anxiety in children with hearing and speech impairment while no correlation was found with behavior. Thus the authors conclude that children with hearing and speech impairment are less anxious and more cooperative compared to normal healthy child in the dental setting and are therefore, easier to manage.

Kanamarlapudi Venkata Saikiran, Rekhalakshmi Kamatham et al (2019)[50] conducted a study to assess the impact of the educational intervention (sign language/video modeling) with or without therapeutic intervention (G.

glabra-liquorice mouth wash) on their oral health status. Ninety-three children with hearing impairment in the age range of 5-15 years were assigned to two educational intervention groups: sign language and video modeling. Each group was again randomly divided into two: with one subgroup receiving therapeutic intervention using liquorice as a mouth wash and the other group receiving no intervention. For all children, baseline oral hygiene, gingival, and plaque index scores were recorded and oral prophylaxis was performed. Based on the subgroup to which the child was assigned, oral hygiene instructions were given on a weekly basis, whereas therapeutic intervention was performed twice daily for 28 days. Reassessment was done after the completion of interventions and after 3 months. The results showed that there was a significant mean reduction in oral hygiene, gingival, and plaque scores in all the children. The educational intervention could positively influence the oral health conditions in CHI, irrespective of the communication method (sign language/video modeling). Thus the authors conclude that the therapeutic intervention using liquorice had a positive impact on the oral health status and it can be suggested as a safe mouth wash, along with educational intervention in hearing impaired children.

Materials & Methodology

MATERIALS AND METHODOLOGY

Materials

The present study "The impact of Sign Language Translator Application as a communication aid on Hearing impaired children during Dental treatment" has been carried out in the Department Of Paediatrics and Preventive Dentistry, Ragas Dental College And Hospital, Uthandi, Chennai to evaluate the effect of the newly developed Indian sign language translator mobile application on anxiety levels and behavior of children with speech and hearing impairment during dental treatment. Ethical clearance was obtained from the Institutional Ethical Committee of Ragas Dental College and Hospital (affiliated to Tamilnadu Dr.M.G.R. Medical University, Chennai (annexure 1). The study period was from August 2018 to September 2019.

ARMAMENTARIUM

1. For investigation:

   A sterile kit with

   - Mouth mirror
   - Straight probe
   - Explorer
   - Tweezer

- Kidney tray
- Mouth mask
- Head caps
- Disposable gloves
- Cotton Holder

2. Oral prophylaxis:
    - Ultrasonic scaler unit and scaler tips
3. Anesthetic agents:
    - Local anesthetic solution
    - Topical anesthesia gel or spray
    - 2.5 ml disposable syringe
4. High-speed airotor hand piece and diamond burs
5. Restorative procedures:
    - Pit and fissure sealants
    - GIC restorative cement (Type II, VII, IX)
    - Zinc oxide eugenol
    - Composite resin.
6. Pulp therapy/ Root canal treatment:
    - Spoon excavators
    - Broaches, K-files and H-files

- Irrigating solution-2% Chlorhexidine, normal saline
- 5ml disposable syringe
- Absorbent paper points
- Obturating materials- Calcium hydroxide and iodoform (METAPEX), Gutta percha points, Root canal sealer.

7. Crown preparation:
    - Stainless steel crown kit
    - Pliers
    - Straight hand piece with green stone burs
    - Band cutting scissors
    - Glass ionomer luting cement
8. Extraction:
    - Periosteal elevator
    - Extraction forceps
9. Pulse oximeter, Facial Image Scale, Behavior rating scale, Child's perception questionnaire, Parental satisfaction questionnaire
10. MISCELLANEOUS:
    - Light cure unit
    - Cotton rolls and suction tips for isolation
    - X-RAY unit and IOPA films
    - Agate spatula and mixing pad

METHODOLOGY

A pilot project was conducted initially to assess the applicability of various available mobile applications to communicate with hearing impaired children. Among them the selected mobile application (SANKET™) was found to be appropriate as it was an Indian sign language translator application but required improvisations with respect to the option of converting speech into Indian sign language, presence of signs related to dentistry in particular and conversion of emoticons into speech or text. For the upgradation of the application, videos of signs related to dentistry were recorded with the help of a professional sign language interpreter and provided to the mobile application developers. These modifications were made and updated by the application developers upon our request (annexure 2). The present available updated version of the application was used for the present study.

A dental screening camp was conducted in various schools for the deaf children across Chennai, India after obtaining consent from the school authorities (annexure 3). A total of 297 hearing impaired children were screened with the assistance of teachers who acted as interpreters, out of which 154 children required dental treatment. Among them, 68 children required single visit treatment procedure and 86 required multi-visit procedures. The Indian sign language application was initially introduced and explained to the hearing

impaired children during the dental screening camp with the help of their teachers. The hearing impaired children, teachers and trainers were asked to use the mobile application and their feedback was obtained.

The treatment needs of the hearing impaired children were informed to their parents or care givers through the school authorities. The children were asked to report to the Department of Paediatrics and Preventive Dentistry, Ragas Dental College with their parents or care givers for undergoing the dental treatment.

A total of 122 hearing impaired children reported to the Department of Paediatrics and Preventive Dentistry, Ragas Dental College. 51 hearing impaired children required single visit procedure who were treated with the help of sign language translator application as a communication mode after reinforcement during their treatment and were not included in the study. The remaining 71 hearing impaired children requiring multi visit treatment who reported were included in the study. The purpose and procedure of the study was explained to the accompanying parent or caregiver and written consent was obtained.

INCLUSION CRITERIA

- Children in the age group of 6 to 13 years with moderate to profound hearing impairment
- Children who are trained and use Indian sign language as their mode of communication.
- Children requiring multiple dental treatment including oral prophylaxis, extraction, restoration, pulp therapy and other procedures.

EXCLUSION CRITERIA

- Children suffering from debilitating systemic illness, mental retardation and associated syndromes, or any other special health care needs that prevent them from undergoing invasive dental treatment at the chairside
- Children requiring a single visit procedure.
- Children whose parents denied their participation

Each child had a minimum of three dental visits. During each visit the following parameters were assessed

1. Child anxiety levels were assessed before and after the dental procedure
    - Subjective anxiety levels were recorded using the Facial Image Scale (FIS) (51) (annexure 6)
    - Objective anxiety levels were recorded with the help of a pulse oximeter

2. Behavior of the child in the dental operatory was assessed using the Frankl's behavior rating scale before and during the dental procedure.(annexure 7)
3. Independent non- operating dentist who was not a part of the study was assigned to judge the interactions between the operating dentist and hearing impaired child during the treatment procedure. Level of understanding and ease of communication were assessed for the nonverbal communication, sign language translator application and interpreter using a five point Likert scale. (annexure 11)

In the first visit, case history was recorded and oral prophylaxis was done for all the subjects with nonverbal communication (facial gestures and simple actions) as a mode of communication between the operating dentist and the hearing impaired child.

Based upon the treatment needs the study population was divided into three groups, Group 1 included hearing impaired children requiring only restorative procedures, group 2 included hearing impaired children requiring either extraction or pulp therapy and group 3 included hearing impaired children requiring combination of treatment procedures. The groups were further divided into two subgroups for performing dental treatment in a crossover manner.

For the subgroup I, in the second visit, dental treatment was done using a sign language interpreter as a communication mode. The parents or caregiver played the role of an interpreter. In the third visit, a quick review of the application was given before the treatment, which acted as reinforcement, after which the dental treatment was done using the Indian sign language translator application. During the procedure, the translator application was used for providing instructions and also to reassure the patients, which acted as a means of communication. The mobile phone was given to the child to use the application to communicate with the operating dentist. For the subgroup II, the mode of communication was used vice versa. The sign language translator application was used in the second visit, followed by the use of interpreter in the third visit.

At the end of the third visit, a questionnaire was given to the hearing impaired children and their parent or caregiver to record their perception regarding the effective mode of communication. Child's perception was obtained using a questionnaire containing 4 closed ended questions regarding the understanding of the instructions given by the dentist with the help of the translator application, their ability to communicate with the dentist through the emoticons, their overall rating the mobile application and the most preferred mode of communication (annexure 12). Parental satisfaction was obtained using a questionnaire containing 3 closed ended questions regarding the ability of the child to cope up with the treatment procedure, child's ability to communicate with

the operating dentist and their opinion about the use of translator application for the future treatment (annexure 13). Based on their response, the most preferred mode of communication for that individual was used in the subsequent visits to complete the dental treatment if required.

The data collected were compiled using MS-Office Excel and was subjected to Statistical analysis using IBM corp. SPSS (Statistical package for social sciences) Statistics for windows, version 20.0 (Armonk, NY). Descriptive and inferential statistics were used to analyze the data. Normality of the data was assessed. Wilcoxon sign rank test was used for within group comparison and Kruskul walis test was used for between group comparisons. Significance was set at P value=<0.05.

Figures

FIGURE 1: ARMAMENTARIUM

FIGURE 2: THE SIGN LANGUAGE TRANSLATOR MOBILE APPLICATION USED IN THE PRESENT STUDY

FIGURE 3: THE CONVERSION OF SPEECH/ TEXT TO INDIAN SIGN LANGUAGE AND CONVERSION OF EMOTICONS TO SPEECH/TEXT

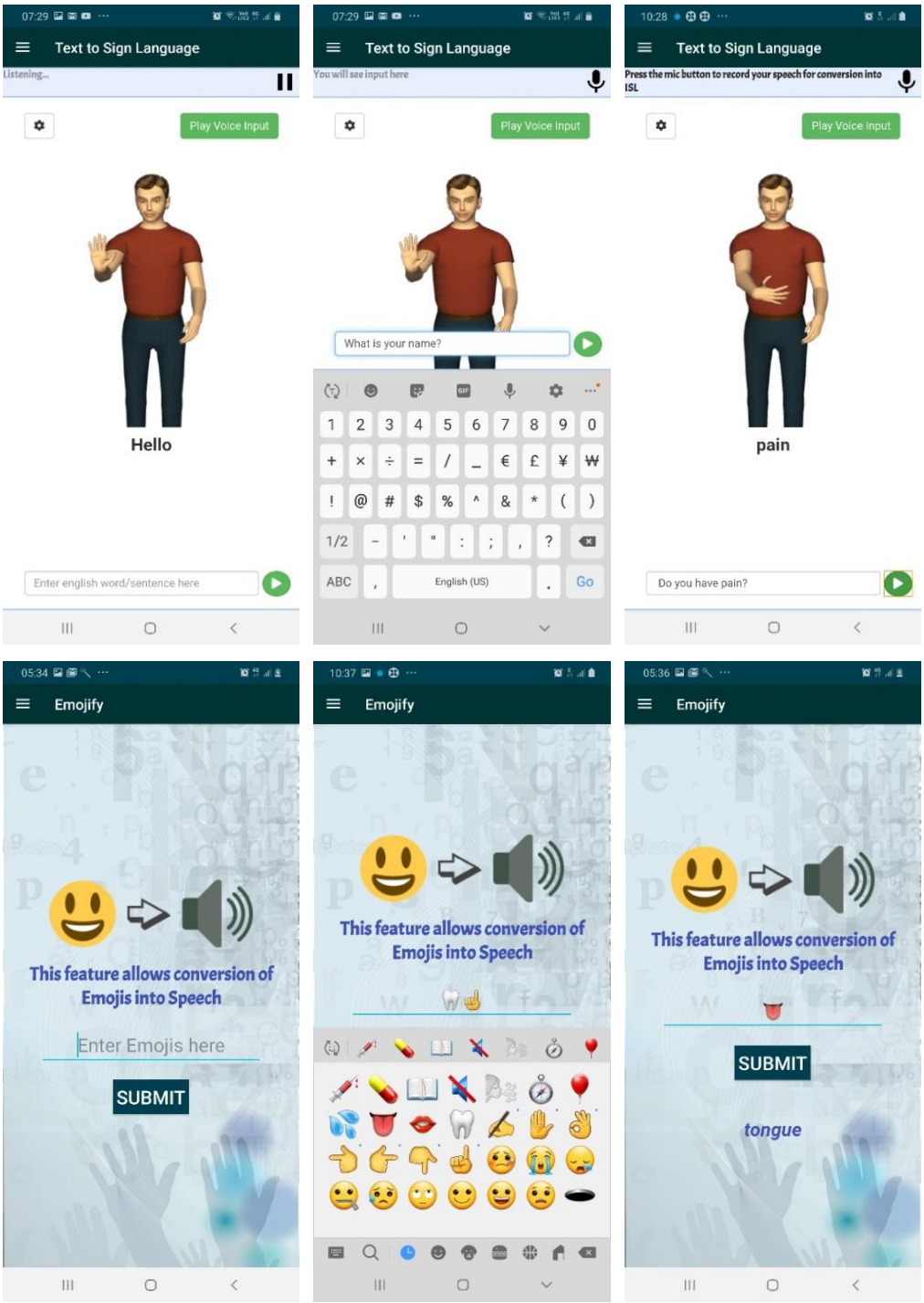


FIGURE 4: EXPLANATION OF THE APPLICATION TO THE SCHOOL TEACHERS AND TRAINERS

FIGURE 5: USE OF NONVERBAL COMMUNICATION TO THE HEARING IMAPIRED CHILD DURING THE DENTAL TREATMENT

FIGURE 6: USE OF SIGN LANGUAGE TRANSLATOR MOBILE APPLICATION DURING THE DENTAL TREATMENT

FIGURE 7: USE OF SIGN LANGUAGE INTERPRETER DURING THE TREATMENT PROCEDURE

Results

RESULTS

DEMOGRAPHICS

A total of 71 hearing impaired children of both the genders in the age group of 6 to 13 years who reported to the Department of Paediatrics and Preventive Dentistry, Ragas Dental College and Hospital were included in this study to evaluate the impact of the sign language translator application on these children during the dental treatment procedure. These children were distributed into one of the three groups based on their treatment needs: group 1- hearing impaired children requiring only restorative procedures, group 2- hearing impaired children requiring either extractions or pulp therapy, group 3- hearing impaired children requiring combination of treatment procedures. Each child's subjective (facial image scale) and objective (pulse rate) anxiety scores, Frankl's behavior ratings and independent observer's ratings in each session were recorded. Questionnaire assessing the child's perception and parental satisfaction were recorded at the end of third visit. The data for 71 hearing impaired children was compiled and subjected to statistical analysis.

GENDER

Table 1, Graph 1 shows distribution of the study population according to their gender and treatment needs. Among the seventy one hearing impaired

children in this study, fifty one (71.83%) were males and twenty (28.16%) were females. Group 1 had twenty two (30.98%) males and eight (11.26%) females. Group 2 had twenty (28.16%) males and four (5.63%) females. Group 3 had nine (12.67%) males and eight (11.26%) females. There is no significant difference in the distribution of males and females across the three groups. ($P > 0.05$)

ANXIETY SCORES OF HEARING IMPAIRED CHILDREN DURING EXPERIMENTAL PERIOD

Table 2, Graph 2a and **2b** shows the anxiety levels of the study population based on mean pulse rate during the experimental period.

With the use of nonverbal communication, there was a significant reduction in the mean pulse rate in group 1, from 98.5 to 95.7, in group 2, from 98.37 to 97.37 and in group 3 from 98.76 to 96.70 ($P \leq 0.05$).

With the use of sign language translator mobile application, there was a highly significant reduction in the mean pulse rate in group 1, from 98.76 to 94.1, in group 2 from 98.16 to 90.15 and in group 3 from 98.41 to 90.94 ($P \leq 0.05$).

With the use of sign language interpreter, there was a highly significant reduction in the mean pulse rate in group 1 from 99.26 to 94.13, in group 2 from 99.04 to 91.75 and in group 3 from 98 to 90.58 ($P \leq 0.05$).

There is significant reduction in anxiety levels based on mean pulse rate between pre intervention and post intervention among the study population ($P \leq 0.05$).

Table 3 shows the effect of mode of communication on anxiety level based on mean pulse rate of the study population during the experimental period. There is no significant difference in anxiety levels based on pulse rate in the pre-treatment session among the study groups ($P \geq 0.05$). Post operatively, there was a significant reduction in anxiety based on pulse rate among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of anxiety reduction between sign language translator application and interpreter ($P \geq 0.005$)

Table 4a and graph 3a shows the assessment of the impact of nonverbal communication on child's anxiety level based on facial image scale

Among the seventy one hearing impaired children, two (2.8%) showed an initial score of '2' who remained unchanged postoperatively. Sixty (84.5%) of the population initially showed the score of '3'. Postoperatively six (8.45%) of them improved to score '1', thirty seven (52.1%) improved to score '2' and seventeen (23.9%) remained unchanged. Nine (12.6%) children had an initial score of '4' who improved to score '2' at the end of the treatment procedure.

There was a significant reduction in the anxiety levels of the study population based on facial image scale during the treatment period with nonverbal communication ($P \leq 0.05$).

Table 4b and **graph 3b** shows the assessment of the impact of sign language translator mobile application on the child's anxiety level based on facial image scale.

In group 1, four (13.3%) children initially showed the score '1' who remained unchanged. Twenty five (83.3%) children who had an initial score of '2' out of which twenty three (76.6%) improved to score '1' and two (6.6%) remained unchanged. One (3.3%) child showed a score of '3' initially improved to score '1' postoperatively.

In group 2, one (4.1%) child initially showed a score of '1' and remained unchanged at the end of the treatment procedure. Nine (37.5%) children showed a score of '2' of which seven (29.1%) improved to score '1' and two (8.3%) remained unchanged. Fourteen (58.3%) children showed a score of '3' initially who all improved to score '1'postoperatively.

In group 3, one (5.8%) child showed a score of '1' initially remained unchanged. Fourteen (82.3%) children showed a score of '2', of which nine (52.9%) improved to '1' and five (29.4%) improved to score '2'. Two (11.7%)

children had an initial score of '3' who improved to score '1' at the end of the treatment procedure.

There was a significant reduction in the anxiety levels of the study population in all the three groups based on facial image scale during the treatment period with translator application ($P \leq 0.05$).

Table 4c and **graph 3c** shows the assessment of the impact of sign language interpreter on the child's anxiety level based on facial image scale

In group 1, four (13.3%) children who showed an initial score of '1' remained unchanged postoperatively. Twenty five (83.3%) children had an initial score of '2', of which twenty four (80%) improved to score '1', one (3.3%) improved to score '2'. One (3.3%) child showed an initial score of '3' which improved to '1'.

In group 2, one (4.1%) child showed an initial score of 1 which remained unchanged. Nine (37.5%) showed an initial score of '2' who improved to score '1'. Fourteen (58.3%) had an initial score of '3' of which eight (33.3%) improved to score '1', five (20.8%) improved to score '2' and one (4.1%) remained unchanged.

In group 3, one (5.8%) showed a score of '1' initially who remained unchanged. Fourteen (82.3%) had an initial score of '2' of which thirteen (58.4%)

improved to score '1' and one (5.8%) remained unchanged. Two (11.7%) showed an initial score of '3' who all improved to score '1'.

There was a significant reduction in the anxiety levels of the study population in all the three groups based on facial image scale during the treatment period with interpreter ($P \leq 0.05$).

Table 5 shows the effect of mode of communication on anxiety level based on facial image scale of the study population during the experimental period. As Facial image scale rating is a categorical variable and not an ordinal variable, comparisons were made according to the mean rank obtained based on Facial image scale rating assigned to the children in each group in the different sessions

There was a significant reduction in anxiety based on facial image scale among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of anxiety reduction between sign language translator application and interpreter ($P \geq 0.005$). There was no significant difference on outcome between the groups.

BEHAVIOR RATINGS OF HEARING IMPAIRED CHILDREN DURING THE EXPERIMENTAL PERIOD

Table 6a and **graph 4a** shows the change in the child's behavior according to Frankl's behavior rating during the treatment procedure when nonverbal communication was used as a communication mode.

Among the study population, sixty (84.5%) children showed positive behavior (rating 3) preoperatively of which eight (11.2%) improved to definitely positive category (rating 4) while fifty two (73.2%) remained unchanged. eleven (15.49%) among the population who were belonging to negative category (rating 2), five (7.04%) of them improved to positive category (rating 3), one (1.4%) improved to definitely positive category (rating 4) whereas five (7.04%) remained unchanged.

A significant improvement was observed in the behavior of the study population during the treatment period with nonverbal communication ($P \geq 0.05$).

Table 6b and graph 4b shows the change in the child's behavior according to Frankl's behavior rating during the treatment procedure when sign language translator mobile application was used as a communicative aid.

In group 1, preoperatively twenty one (80%) children were belonging to positive category (rating 3) who all improved to definitely positive (rating 4)

during the treatment procedure. The remaining six (20%) children were belonging to definitely positive category (rating 4) who remained unchanged.

In group 2, five (20.8%) children who showed negative behavior (rating 2) improved to definitely positive category (rating 4) during the treatment procedure. eighteen (75%) children who showed positive behavior of which thirteen (54.1%) improved to definitely positive category (rating 4) and five (20.8%) remained unchanged. One (4.1%) child who showed definitely positive behavior remained unchanged during the treatment procedure.

In group 3, fifteen (88.2%) children who showed positive behavior (rating 3), during the treatment procedure, eleven (64.7%) of them improved to definitely positive (rating 4) while four (23.5%) remained unchanged. Two (11.7%) children who showed definitely positive behavior preoperatively remained unchanged.

There was a significant improvement in the behavior of the study population in all the three groups during the treatment period with translator application ($P \leq 0.05$).

Table 6c and **graph 4c** shows the change in the child's behavior according to Frankl's behavior rating during the treatment procedure when sign language interpreter was used as a communication mode.

In the group 1, preoperatively, twenty four (80%) were belonging to positive category (rating 3) of which twenty three (76.6%) of them improved to definitely positive category (rating 4) and one (3.3%) remained unchanged. Six (20%) children who showed definitely positive behavior (rating 4) remained unchanged during the treatment procedure.

In group 2, five (20.8%) children were belonging to negative category (rating 2) preoperatively of which three (12.5%) improved to definitely positive category (rating 4) and two (8.3%) improved to positive category (rating 3). eighteen (75%) children who showed positive behavior (rating 3) of which sixteen (66.6%) showed improvement to definitely positive category (rating 4) while two (8.3%) children remained unchanged. One (4.1%) child who showed definitely positive behavior (rating 4) remained unchanged during the treatment.

In group 3, preoperatively fifteen (88.2%) children were belonging to positive category (rating 3), twelve (70.5%) among them improved to definitely positive category (rating 4) while three (17.6%) remained unchanged (rating 3) at the end of treatment procedure. Two (11.7%) children who showed definitely positive behavior (rating 4) remained unchanged.

There was a significant improvement in the behavior of the study population in all the three groups during the treatment period with interpreter ($P \leq 0.05$).

Table 7, graph shows the effect of mode of communication on behavior of the study population during the experimental period.

As Frankl's behavior rating is a categorical variable and not an ordinal variable, comparisons were made according to the mean rank obtained based on Frankl's rating assigned to the children in each group in the different sessions.

Wilcoxon signed rank test was used for comparison between the three modes of communication. There was a significant improvement in the behavior among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of change in behavior between sign language translator application and interpreter ($P \geq 0.005$). There was no significant difference on outcome between the groups.

INDEPENDENT OBSERVER'S RATING

Table 8 and **graph 5** shows the response of the independent non-operating dentist who was assigned as an observer for all the three sessions. The responses were recorded on a 5-point Likert scale regarding the level of understanding and ease of communication between the operating dentist and hearing impaired children during the treatment procedure.

With nonverbal communication, the observer noted that fifty eight (81.69%) children were trying to communicate and understand with some difficulty, eight (11.26%) children were finding it easy to understand and were able to communicate to some extent, three (4.22%) were able to easily understand as well as communicate and two (2.8%) understood on repetition and were trying to communicate.

With sign language translator mobile application, the observer noted that forty eight (67.6%) children were able to easily understand and communicate, twenty (28.16%) found it easy to understand with communicated to some extent and three (4.22%) were trying to understand and communicate with some difficulty.

With sign language interpreter, the observer noted that fifty (70.42%) children were able to easily understand as well as communicate and twenty one (29.57%) found it easy to understand but communicated to some extent.

CHILD'S PERCEPTION

Tables 9 and graph 6 a, b, c, d shows the responses of the seventy one hearing impaired children regarding their perception about the use of the sign language translator application during the treatment procedure.

Among the study population, sixty two (87.32%) hearing impaired children were able to understand the instructions given by the operating dentist using the translator application easily, whereas seven (9.85%) of them understood with repetitions and two (2.81%) found it difficult to understand. Forty eight (67.60%) hearing impaired children were able to communicate easily with the operating dentist using the emoticons, whereas twenty one (29.57%) were able to communicate to some extent and two (2.8%) of them were totally unable to communicate.

Among the seventy one hearing impaired children, forty nine (69.01%) rated the application with the score of 4, eighteen (25.35%) with the score of 5 and four (5.63%) rated it 3. Forty eight (67.60%) hearing impaired children selected mobile application, twenty three (32.39%) selected interpreter and none selected nonverbal communication as their preferred mode of communication in their future dental appointments.

PARENTAL SATISFACTION

Tables 10 and **figures 7 a, b, c** shows the responses of the parents or caregiver's satisfaction, who accompanied the hearing impaired children during their treatment sessions. Among the study subjects, sixty nine (97.2%) parents reported that the hearing impaired children were able to cope up with the treatment with no difficulties using the mobile application alone, two (2.8%) of them reported that the children required some adjuncts for communicating. Sixty two (87.3%) parents reported that hearing impaired children were able to communicate easily, six (8.4%) of them reported that the children communicated to some extent and three (4.2%) parents reported that it was difficult for the hearing impaired children to communicate with the dentist. Sixty eight (98.5%) parents selected the mobile application as the preferred mode of communication for the hearing impaired children during the dental treatment procedure whereas three (4.2%) parents reported that it can be used after few modifications or along with other modes.

Tables & Graphs

TABLE 1: DISTRIBUTION OF THE STUDY POPULATION ACCORDING TO GENDER AND TREATMENT NEEDS

GROUP	MALE (n) %	FEMALE (n) %	TOTAL (n) %
GROUP 1	22 (29.57%)	8 (11.26%)	30 (42.25%)
GROUP 2	20 (28.16%)	4 (5.63%)	24 (33.80%)
GROUP 3	9 (12.67%)	8 (11.26%)	17 (23.94%)
TOTAL	51 (71.83%)	20 (28.16%)	71 (100%)

INFERENCE:

P-value = 0.083

There is no significant difference in distribution of males and females across the three groups. (P> 0.05)

TABLE 2: ANXIETY LEVELS BASED ON MEAN PULSE RATE OF THE STUDY POPULATION DURING EXPERIMENTAL PERIOD

GROUP	MODE OF COMMUNICATION	PRE INTERVENTION Mean ± SD	POST INTERVENTION Mean ± SD	P-VALUE
Group 1	Nonverbal communication	98.5± 1.0	95.7 ± 2.94	0.000**
	Translator application	98.7± 3.2	94.1 ± 3.02	0.000**
	Sign language interpreter	99.2 ± 3.88	94.13 ± 3.74	0.000**
Group 2	Nonverbal communication	98.37 ± 3.03	97.37 ± 3.85	0.052*
	Translator application	98.16 ± 2.42	90.9 ± 2.40	0.000**
	Sign language interpreter	99.04 ± 3.16	91.75 ± 3.22	0.000**
Group 3	Nonverbal communication	98.76 ± 1.14	96.70 ± 1.64	0.000**
	Translator application	98.41 ± 2.23	90.94 ± 2.19	0.000**
	Sign language interpreter	98 ± 2.23	90.58 ± 2.18	0.000**

INFERENCE:

There is significant reduction in anxiety levels based on mean pulse rate between pre intervention and post intervention among the study population ($P \leq 0.05$).

TABLE 3: EFFECT OF MODE OF COMMUNICATION ON ANXIETY LEVEL BASED ON MEAN PULSE RATE OF THE STUDY POPULATION DURING THE EXPERIMENTAL PERIOD

GROUPS	NONVERBAL Vs APPLICATION (P VALUE)	APPLICATION Vs INTERPRETER (P VALUE)	INTERPRETER Vs NONVERBAL (P VALUE)
GROUP 1	0.034**	0.110	0.045**
GROUP 2	0.000**	0.403	0.000**
GROUP 3	0.000**	0.643	0.000**

INFERENCE:

There was a significant reduction in anxiety based on pulse rate among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of anxiety reduction between sign language translator application and interpreter ($P \geq 0.005$)

TABLE 4A: EFFECT OF NONVERBAL COMMUNICATION ON CHILD'S ANXIETY LEVEL BASED ON FACIAL IMAGE SCALE

SCORE	PRE INTERVENTION	POST INTERVENTION				
		Score 1	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 1 Number percentage	0	-	-	-	-	-
Score 2 Number percentage	2 (2.8%)	-	2 (2.8%)	-	-	-
Score 3 Number percentage	60 (84.5%)	6 (8.45%)	37 (52.1%)	17 (23.9%)	-	-
Score 4 Number percentage	9 (12.6%)	-	9 (12.6%)	-	-	-
Score 5 Number percentage	0	-	-	-	-	-

INFERENCE:

Pre Intervention Vs Post Intervention P- Value = 0.000**

There was a significant reduction in the anxiety levels of the study population based on facial image scale during the treatment period with nonverbal communication ($P \leq 0.05$).

TABLE 4B: EFFECT OF SIGN LANGUAGE TRANSLATOR APPLICATION ON CHILD'S ANXIETY BASED ON FACIAL IMAGE SCALE

GROUPS	SCORE	PRE INTERVENTION	POST INTERVENTION				
			Score 1	Score 2	Score 3	Score 4	Score 5
1	Score 1	4 (13.3%)	4 (13.3%)	-	-	-	-
	Score 2	25 (83.3%)	23 (76.6%)	2 (6.6%)	-	-	-
	Score 3	1 (3.3%)	1(3.3%)	-	-	-	-
	Score 4	0	-	-	-	-	-
	Score 5	0	-	-	-	-	-
2	Score 1	1 (4.1%)	1(4.1%)	-	-	-	-
	Score 2	9 (37.5%)	7 (29.1%)	2(8.3%)	-	-	-
	Score 3	14 (58.3%)	14 (58.3%)	-	-	-	-
	Score 4	0	-	-	-	-	-
	Score 5	0	-	-	-	-	-
3	Score 1	1 (5.8%)	1 (5.8%)	-	-	-	-
	Score 2	14 (82.3%)	9 (52.9%)	5 (29.4%)	-	-	-
	Score 3	2 (11.7%)	2 (11.7%)	-	-	-	-
	Score 4	0	-		-	-	-
	Score 5	0	-	-	-	-	-

INFERENCE:

Pre Intervention Vs Post Intervention

Group 1, 2, 3: p-value = 0.000**

There was a significant reduction in the anxiety levels of the study population in all the three groups based on facial image scale during the treatment period with translator application ($P \leq 0.05$).

TABLE 4C: EFFECT OF SIGN LANGUAGE INTERPRETER ON CHILD'S ANXIETY LEVEL BASED ON FACIAL IMAGE SCALE

GROUPS	SCORE	PRE INTERVENTION	POST INTERVENTION				
			Score 1	Score 2	Score 3	Score 4	Score 5
1	Score 1	4 (13.3%)	4 (13.3%)	-	-	-	-
	Score 2	25 (83.3%)	24 (80%)	1 (3.3%)	-	-	-
	Score 3	1 (3.3%)	1 (3.3%)	-	-	-	-
	Score 4	0	-	-	-	-	-
	Score 5	0	-	-	-	-	-
2	Score 1	1 (4.1%)	1 (4.1%)	-	-	-	-
	Score 2	9 (37.5%)	9 (37.5%)	-	-	-	-
	Score 3	14 (58.3%)	8 (33.3%)	5 (20.8%)	1 (4.1%)	-	-
	Score 4	0	-	-	-	-	-
	Score 5	0	-	-	-	-	-
3	Score 1	1 (5.8%)	1(5.8%)	-	-	-	-
	Score 2	14 (82.3%)	13 (58.4%)	1 (5.8%)	-	-	-
	Score 3	2 (11.7%)	2 (11.7%)	-	-	-	
	Score 4	0	-	-	-	-	-
	Score 5	0	-	-	-	-	-

INFERENCE:

Pre Intervention Vs Post Intervention

Group 1, 2, 3: p-value = 0.000**

There was a significant reduction in the anxiety levels of the study population in all the three groups based on facial image scale during the treatment period with interpreter ($P \leq 0.05$).

TABLE 5: EFFECT OF MODE OF COMMUNICATION ON ANXIETY LEVEL BASED ON FACIAL IMAGE SCALE OF THE STUDY POPULATION DURING THE EXPERIMENTAL PERIOD

GROUP	NONVERBAL VS APPLICATION (P VALUE)	APPLICATION VS INTERPRETER (P VALUE)	INTERPRETER VS NONVERBAL (P VALUE)
GROUP 1	0.000**	0.480	0.000**
GROUP 2	0.000**	0.705	0.000**
GROUP 3	0.000**	0.564	0.001**

INFERENCE:

There was a significant reduction in anxiety based on facial image scale among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of anxiety reduction between sign language translator application and interpreter ($P \geq 0.005$). There was no significant difference on the outcome between the three groups.

TABLE 6A: EFFECT OF NONVERBAL COMMUNICATION ON CHILD'S BEHAVIOR DURING EXPERIMENTAL PERIOD

RATING	**PRE INTERVENTION**	**DURING INTERVENTION**			
		Rating 1	**Rating 2**	**Rating 3**	**Rating 4**
Rating 1 Number Percentage	0	-	-	-	-
Rating 2 Number Percentage	11 (15.49%)	-	5 (7.04%)	5 (7.04%)	1 (1.4%)
Rating 3 Number Percentage	60 (84.5%)	-	-	52 (73.2%)	8 (11.2%)
Rating 4 Number Percentage	0	-	-	-	-

INFERENCE:

P- Value = 0.039**

A significant improvement was observed in the behavior of the study population during the treatment period with nonverbal communication ($P \geq 0.05$).

TABLE 6B: EFFECT OF TRANSLATOR APPLICATION ON CHILD'S BEHAVIOR DURING EXPERIMENTAL PERIOD

GROUPS	RATING	PRE INTERVENTION	DURING INTERVENTION			
			Rating 1	Rating 2	Rating 3	Rating 4
1	1	0	-	-	-	-
	2	0	-	-	-	-
	3	24 (80%)	-	-	-	24 (80%)
	4	6 (20%)	-	-	-	6 (20%)
2	1	0	-	-	-	-
	2	5 (20.8%)	-	-	-	5 (20.8%)
	3	18 (75%)	-	-	5 (20.8%)	13 (54.1%)
	4	1 (4.1%)	-	-	-	1 (4.1%)
3	1	0	-	-	-	
	2	0	-	-	-	-
	3	15 (88.2%)	-	-	4 (23.5%)	11 (64.7%)
	4	2 (11.7%)	-	-	-	2 (11.7%)

INFERENCE:

Pre Intervention Vs Post Intervention

Group 1, 2, 3: p-value = 0.000**

There was a significant improvement in the behavior of the study population in all the three groups during the treatment period with translator application ($P \leq 0.05$).

TABLE 6C: EFFECT OF SIGN LANGUAGE INTERPRETER ON CHILD'S BEHAVIOR DURING EXPERIMENTAL PERIOD

GROUPS	RATING	PRE INTERVENTION	DURING INTERVENTION			
			Rating 1	Rating 2	Rating 3	Rating 4
1	1	0	-	-	-	-
	2	0	-	-	-	-
	3	24 (80%)	-	-	1 (3.3%)	23(76.6%)
	4	6 (20%)	-	-	-	6 (20%)
2	1	0	-	-	-	-
	2	5 (20.8%)	-	-	2 (8.3%)	3 (12.5%)
	3	18 (75%)			2 (8.3%)	16 (66.6%)
	4	1 (4.1%)	-	-	-	1 (4.1%)
3	1	0	-	-	-	-
	2	0	-	-	-	-
	3	15 (88.2%)	-	-	3 (17.6%)	12 (70.5%)
	4	2 (11.7%)	-	-	-	(11.7%)

INFERENCE:

Pre Intervention Vs Post Intervention

Group 1, 2: p-value = 0.000**

Group 3: p- value = 0.001**

There was a significant improvement in the behavior of the study population in all the three groups during the treatment period with interpreter ($P \leq 0.05$).

TABLE 7: EFFECT OF MODE OF COMMUNICATION ON BEHAVIOR OF THE STUDY POPULATION DURING THE EXPERIMENTAL PERIOD

GROUP	NONVERBAL VS APPLICATION (P VALUE)	APPLICATION VS INTERPRETER (P VALUE)	INTERPRETER VS NONVERBAL (P VALUE)
GROUP 1	0.000**	1.000	0.000**
GROUP 2	0.000**	0.739	0.000**
GROUP 3	0.000**	1.000	0.000**

INFERENCE:

There was a significant improvement in behavior among all the three groups with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of change in behavior between sign language translator application and interpreter ($P \geq 0.005$). There was no significant difference on the outcome between the three groups.

TABLE 8: INDEPENDENT OBSERVER'S RATING ON CHILD'S LEVEL OF UNDERSTANDING AND THEIR EASE OF COMMUNICATION

MODE OF COMMUNICATION	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Nonverbal communication	0	2 (2.8%)	58 (81.69%)	8 (11.26%)	3 (4.22%)
translator application	0	0	3 (4.22%)	20 (28.16%)	48 (67.6%)
Sign language interpreter	0	0	0	21 (29.57%)	50 (70.42%)

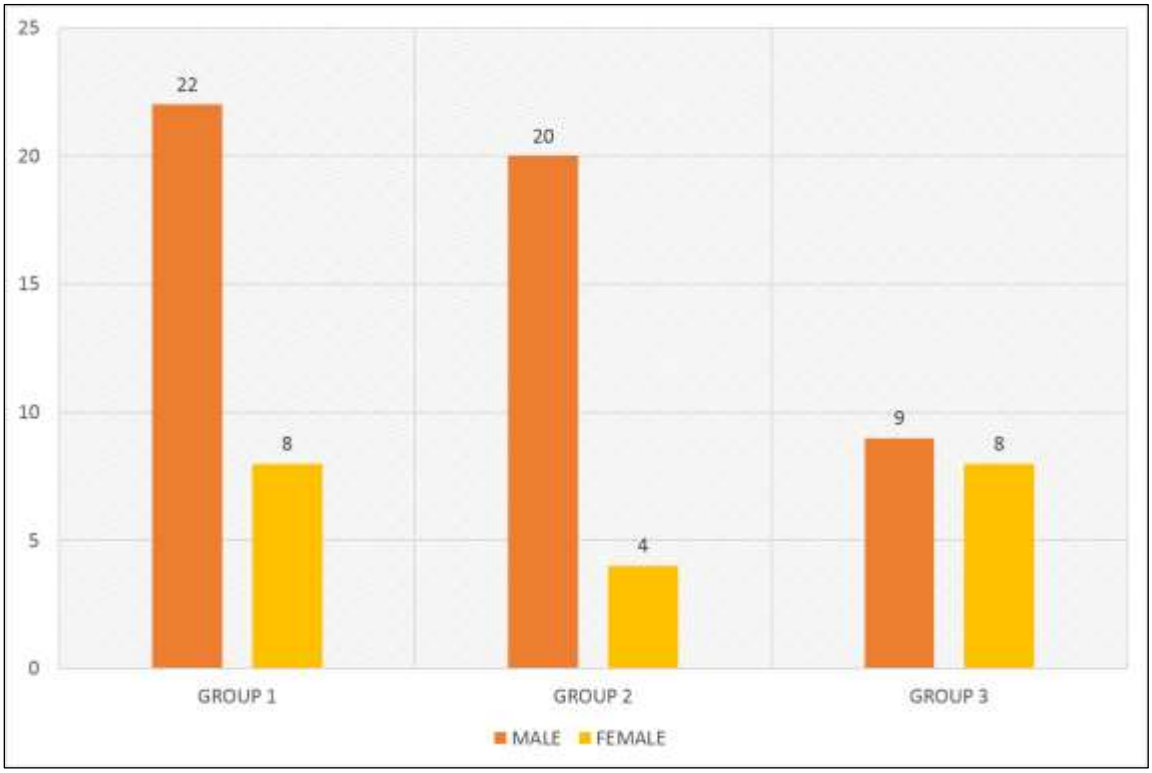
TABLE 9: RESPONSES OF STUDY SUBJECTS REGARDING THEIR PERCEPTION ON USING THE SIGN LANGUAGE TRANSLATOR APPLICATION

QUESTION	RESPONSES	(n)
Understanding of the instructions	Easy	62 (87.3%)
	Required repetition	7 (9.8%)
	Difficult	2 (2.8%)
Communicating with the dentist	Able	48 (67.6%)
	To some extent	21 (29.57%)
	unable	2 (2.8%)
Rating of the application	1 star	0
	2 star	0
	3 star	4 (5.6%)
	4 star	49 (69%)
	5 star	18 (25.3%)
Preferred mode of communication	Nonverbal communication	0
	Translator application	48 (67.6%)
	interpreter	23 (32.39%)

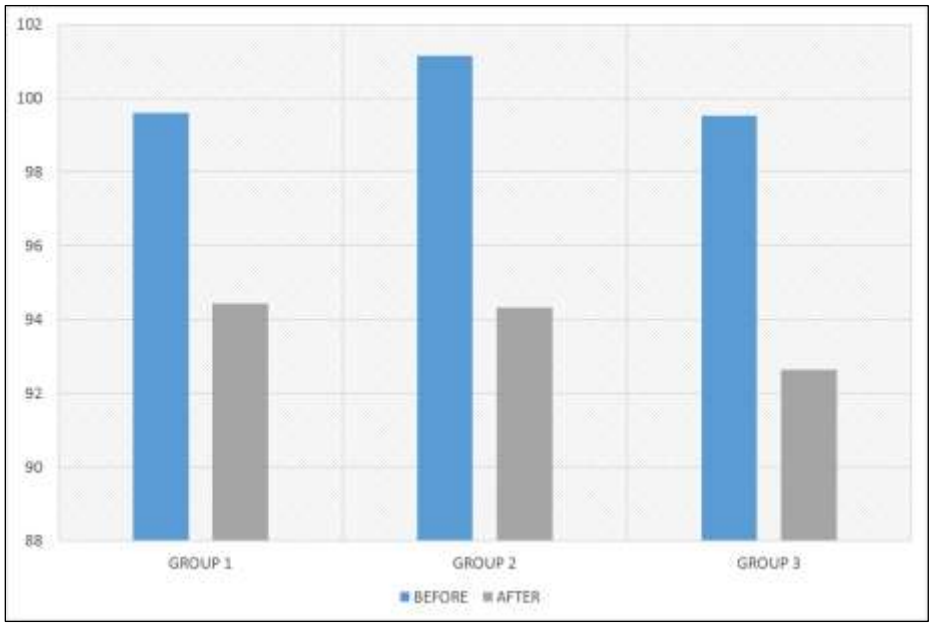
TABLE 10: RESPONSES OF PARENTS OR CAREGIVERS REGARDING THEIR SATISFACTION ON USING THE SIGN LANGUAGE TRANSLATOR APPLICATION

QUESTIONS	RESPONSES	(N)
Child's ability to cope up with the treatment	Able to	69 (97.2%)
	To some extent	2 (2.8%)
	Difficult	0
Ability to communicate	Able to	62 (87.3%)
	To some extent	6 (8.4%)
	Difficult	3 (4.2%)
Use of app for the future	Recommended	68 (98.5%)
	Use with other modes	3 (4.2%)
	Not recommended	0

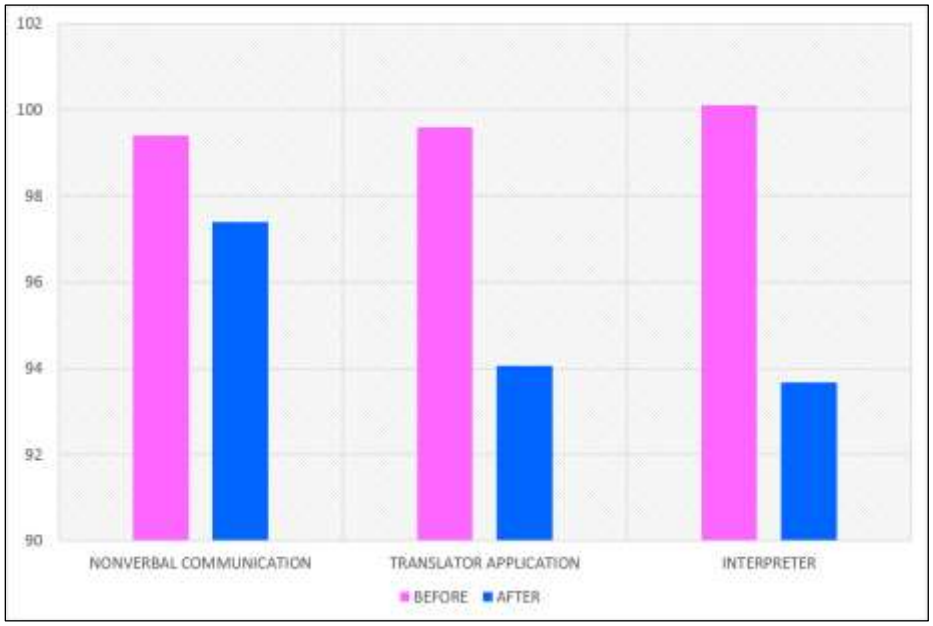
GRAPH 1: DISTRIBUTION OF STUDY POPULATION BASED ON GENDER AND TREATMENT NEEDS



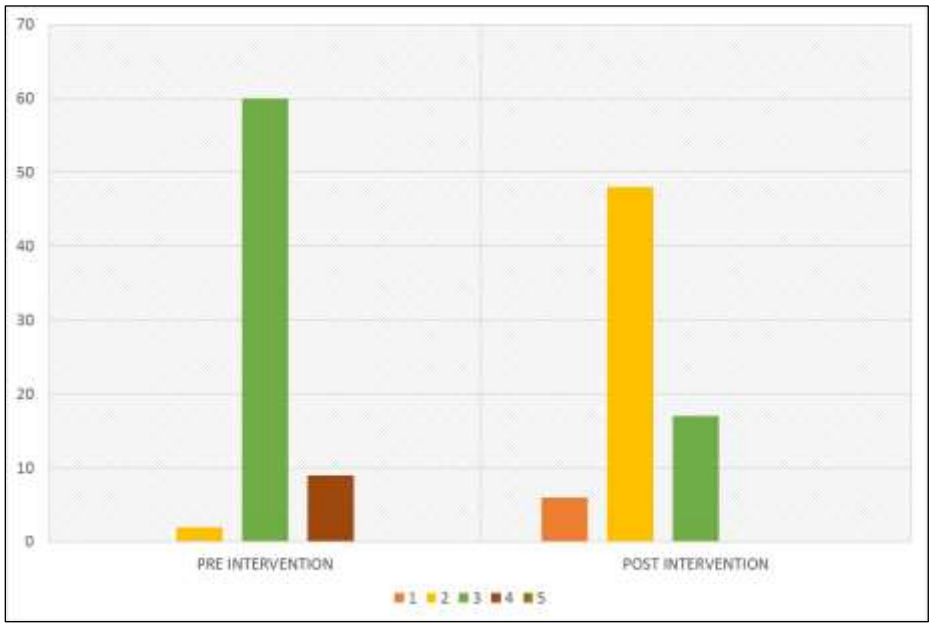
GRAPH 2A: MEAN PULSE RATE OF THE STUDY POPULATION BASED ON TREATMENT NEEDS DURING EXPERIMENTAL PERIOD



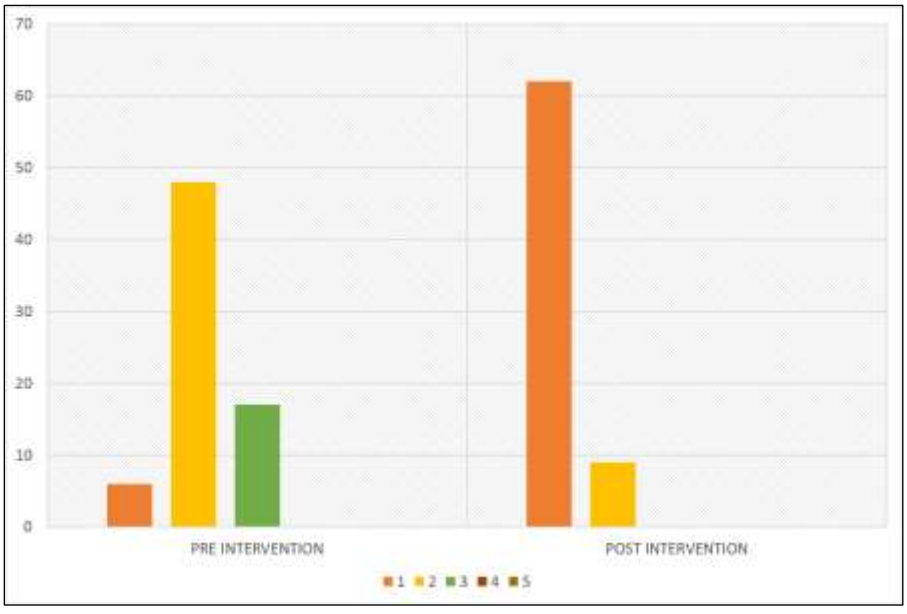
GRAPH 2B: MEAN PULSE RATE OF THE STUDY POPULATION BASED ON THE MODE OF COMMUNICATION



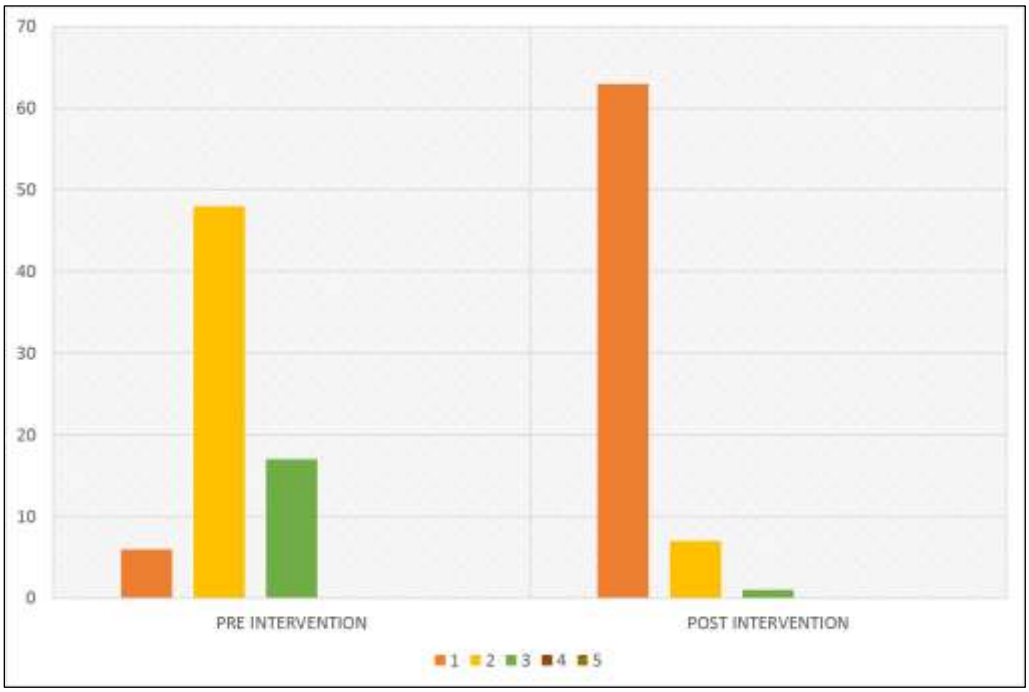
GRAPH 3A: ANXIETY LEVELS OF THE STUDY POPULATION BASED ON THE FACIAL IMAGE SCALE WITH NONVERBAL COMMUNICATION



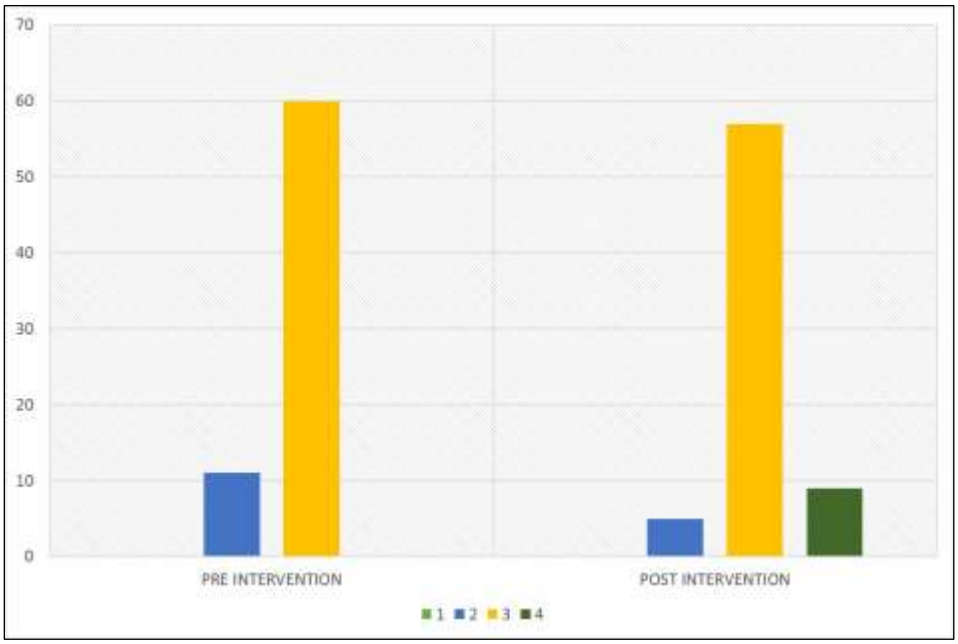
GRAPH 3B: ANXIETY LEVELS OF THE STUDY POPULATION BASED ON THE FACIAL IMAGE SCALE WITH TRANSLATOR APPLICATION



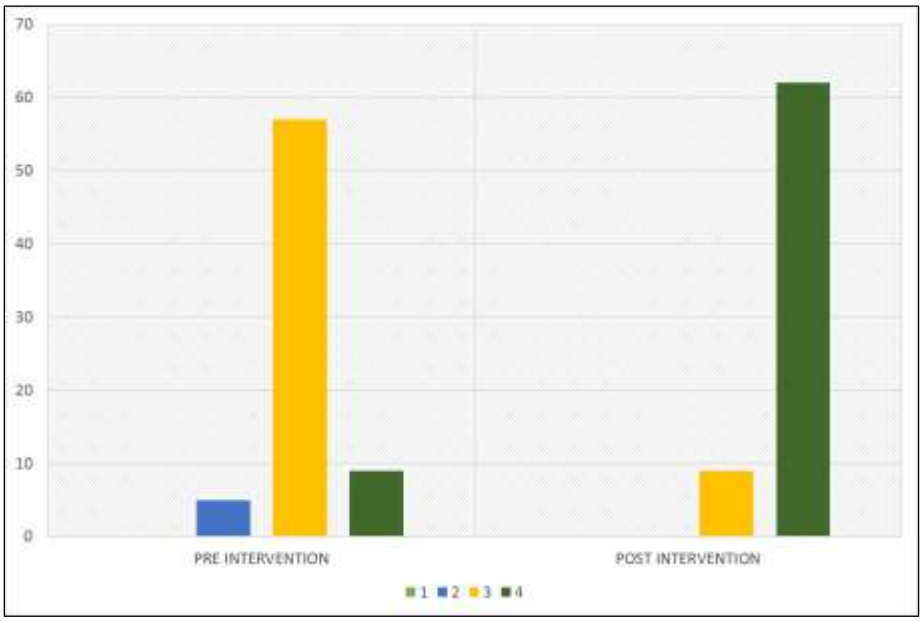
GRAPH 3C: ANXIETY LEVELS OF THE STUDY POPULATION BASED ON THE FACIAL IMAGE SCALE WITH SIGN LANGUAGE INTERPRETER



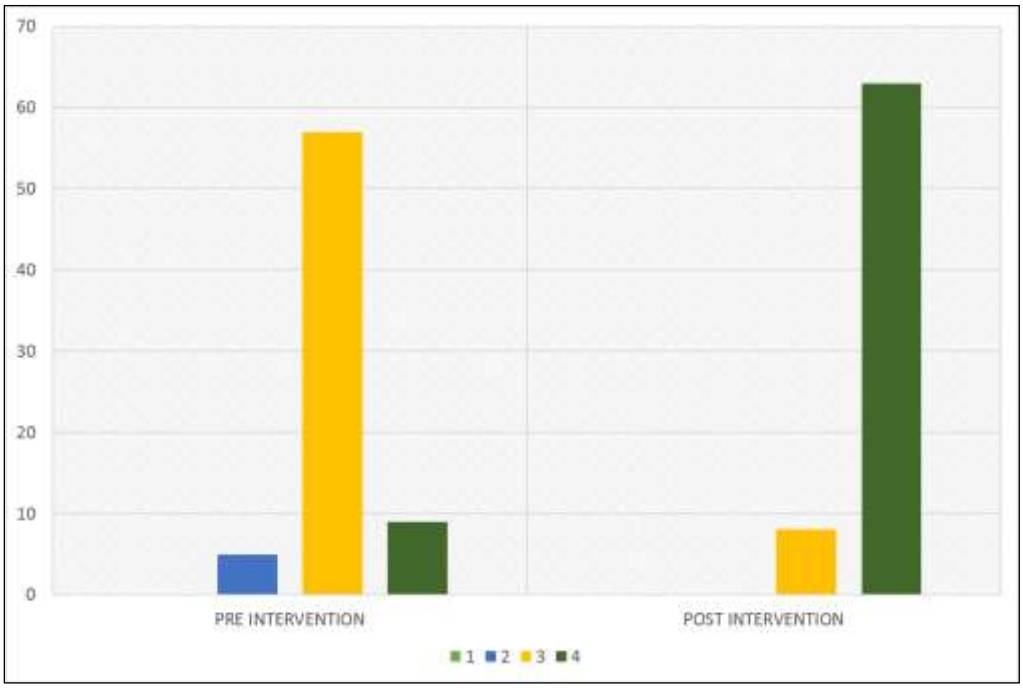
GRAPH 4A: BEHAVIOR RATINGS OF THE STUDY POPULATION WITH NONVERBAL COMMUNICATION



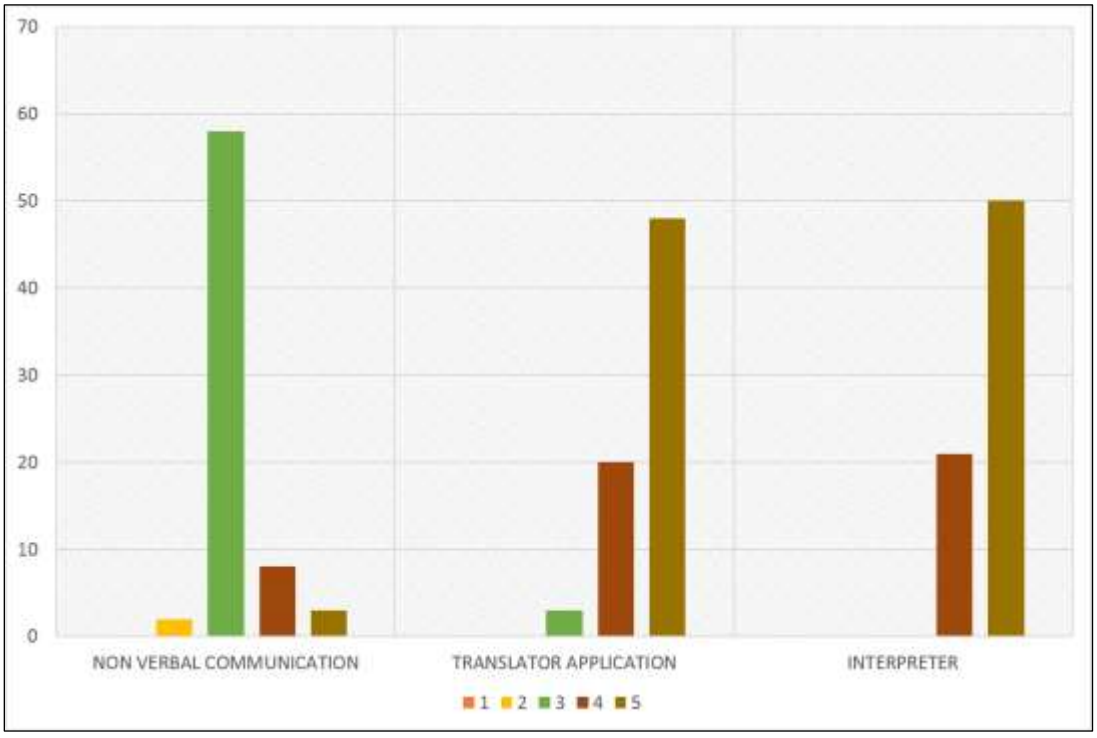
GRAPH 4B: BEHAVIOR RATINGS OF THE STUDY POPULATION WITH TRANSLATOR APPLICATION



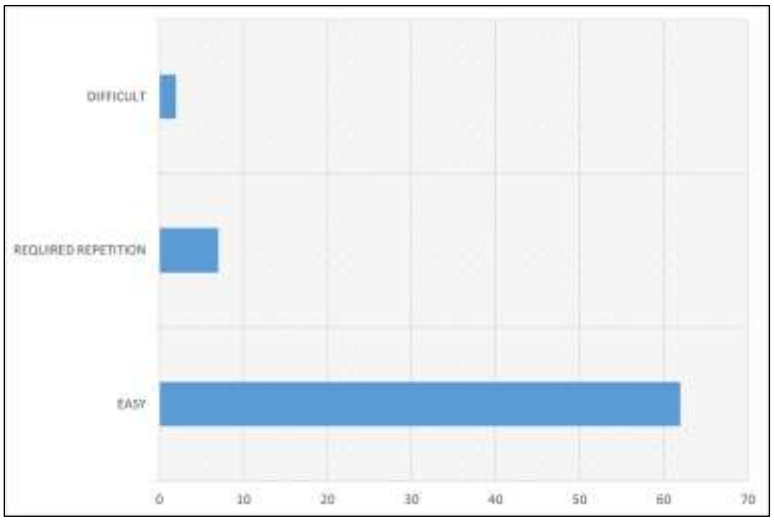
GRAPH 4C: BEHAVIOR RATING OF THE STUDY POPULATION WITH SIGN LANGUAGE INTERPRETER



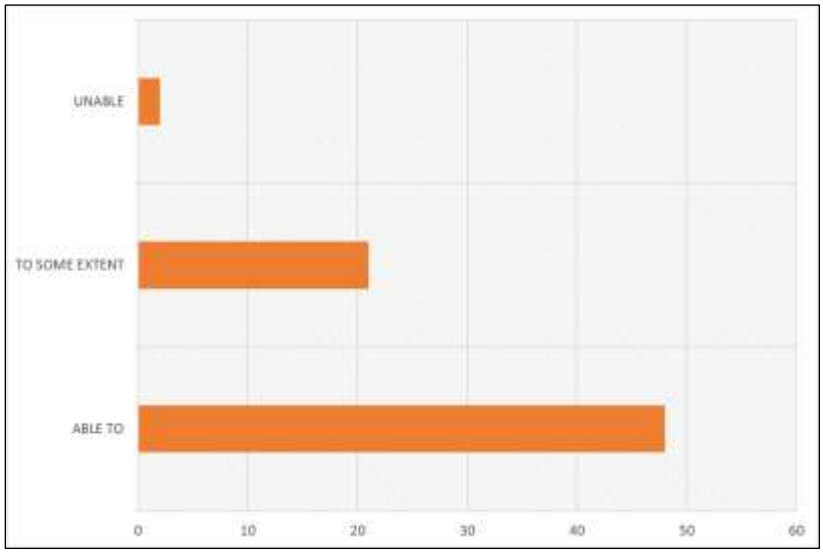
GRAPH 5: RESPONSE OF THE INDEPENDENT NON- OPERATING DENTIST REGARDING THE LEVEL OF UNDERSTANDING AND EASE OF COMMUNICATION



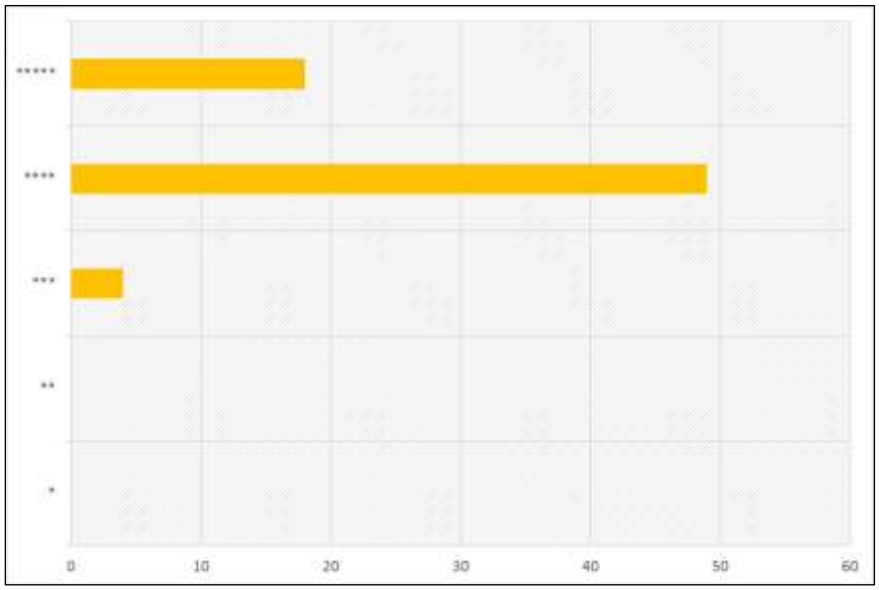
GRAPH 6A: RESPONSE OF THE STUDY POPULATION REGARDING THE UNDERSTANDING OF THE APPLICATION



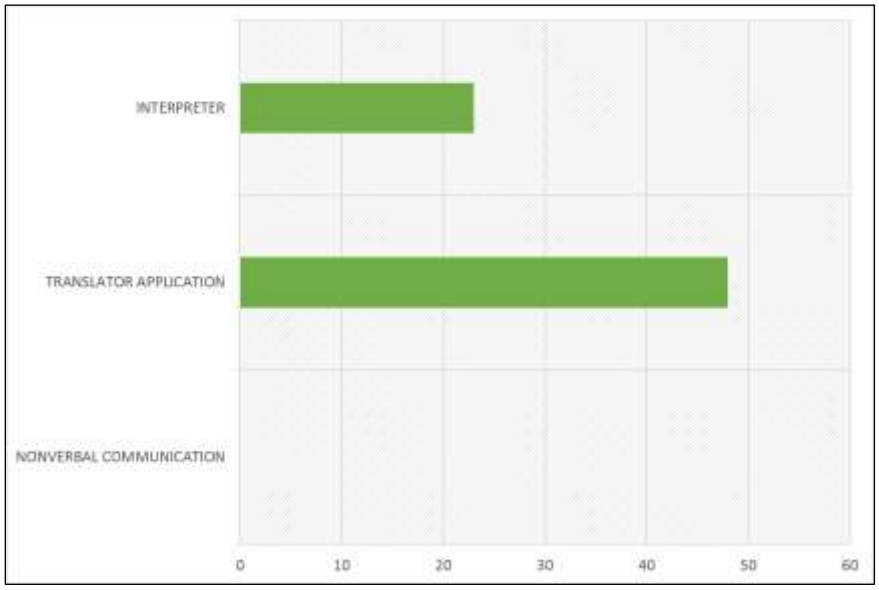
GRAPH 6B: RESPONSE OF THE STUDY POPULATION REGARDING THE ABILITY TO COMMUNICATE WITH EMOTICONS



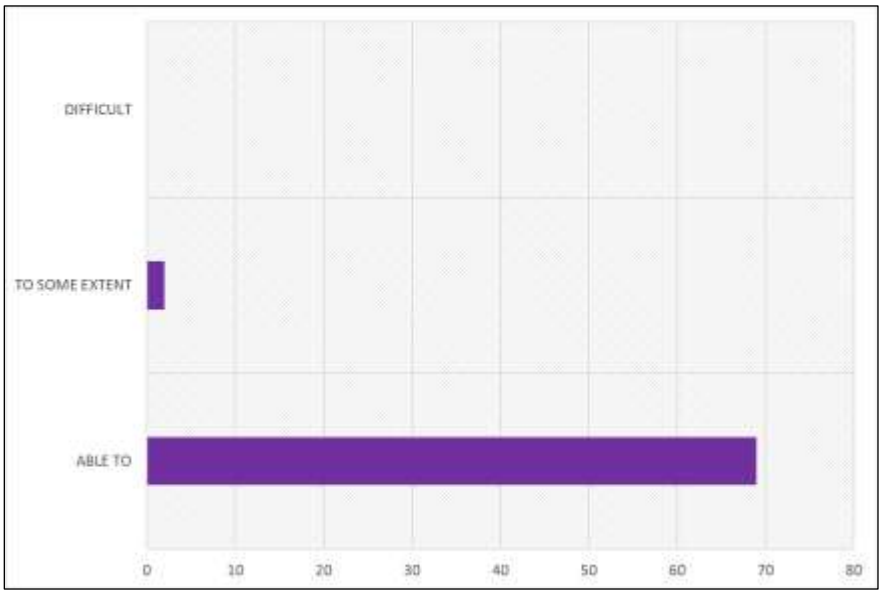
GROUP 6C: RESPONSE OF THE STUDY POPULATION REGARDING THE OVERALL RATING OF THE TRANSLATOR APPLICATION



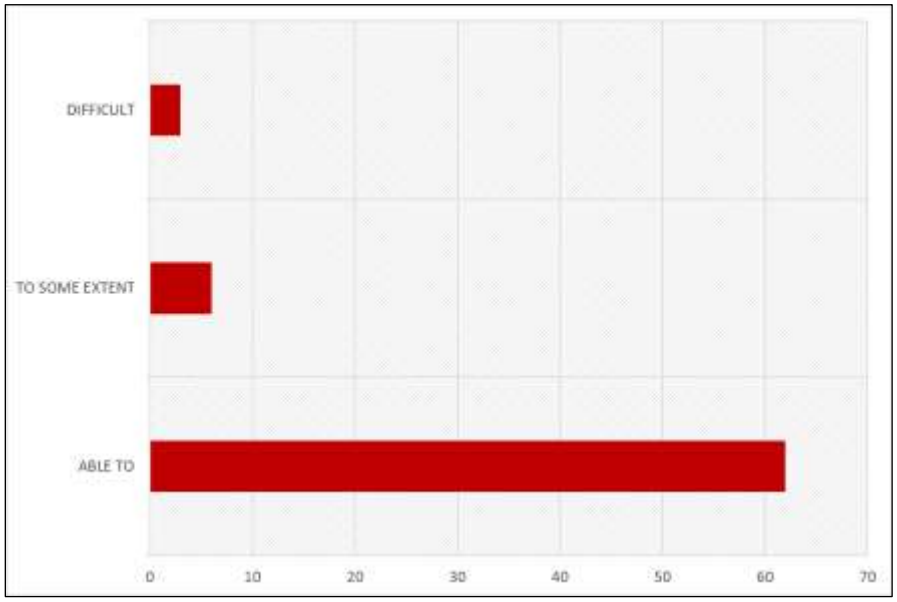
GRAPH 6D: RESPONSES OF THE STUDY POPULATION REGARDING THE PREFERRED MODE OF COMMUNICATION



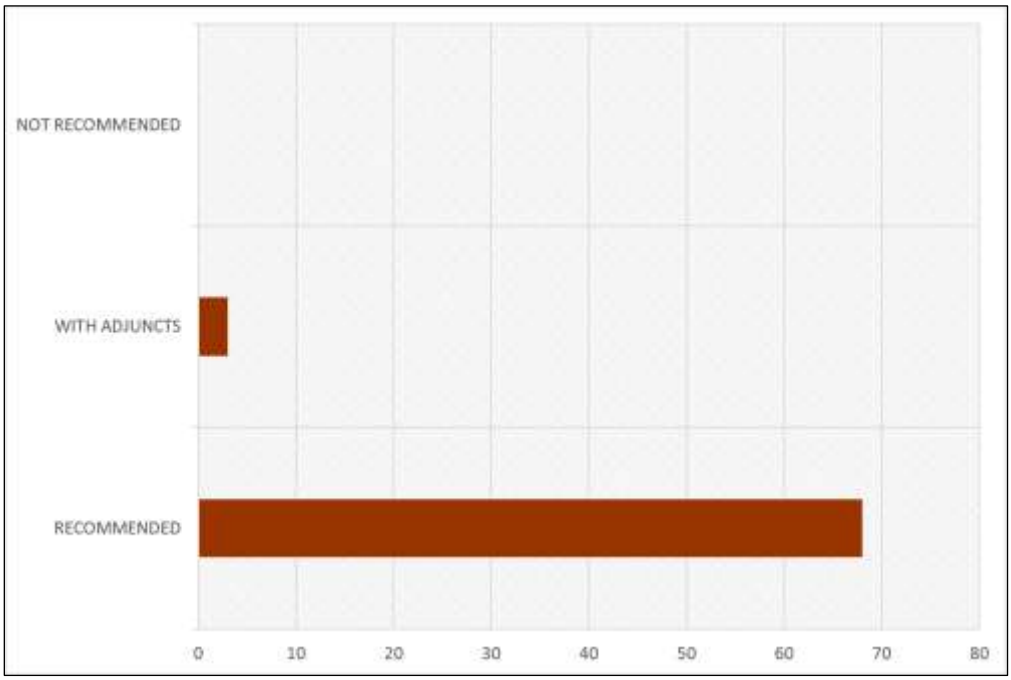
GRAPH 7A: RESPONSE OF THE PARENT OR CAREGIVER REGARDING THE ABILITY OF THEIR CHILD TO COPE UP WITH THE TREATMENT



GRAPH 7B: RESPONSE OF THE PARENTS OR CAREGIVERS REGARDING THE ABILITY OF THEIR CHILD TO COMMUNICATE WITH THE DENTIST



GRAPH 7C: RESPONSE OF THE PARENTS OR CAREGIVERS REGARDING THE FUTURE USE OF THE TRANSLATOR APPLICATION



Discussion

DISCUSSION

Hearing impairment refers to a condition in which individuals are fully or partially unable to detect some frequencies of sound that are heard by the normal people. [4] Hearing impairment primarily influences communication which is the biggest barrier that limits the chance of acquiring information which in turn affects their lifestyle and overall health. [27] Moreover, children with hearing impairment are one important group deprived of good oral health with a higher caries prevalence and higher mean number of decayed teeth compared to normal hearing children due to communication difficulties [51, 8, 7, 28, 31, 33, 42, 44, 45]

Dental anxiety is a common problem that appears to develop mostly in childhood and adolescence which can prevent patients from cooperating during dental treatment. The strategies adopted by the dentist to reduce anxiety and to develop a trusted relationship with the child can be further more compromised in hearing impaired children due to their difficulties in communication. It may be necessary to alter the management protocol in a personalized manner. [8] At the same time, the different modes used by the hearing impaired children (sign language, lip reading, fingerspelling, hearing aids and cochlear implants, written information, either singly or in combination) to understand and communicate with others must also be considered while planning strategies to handle these children during dental treatment. [8,11] Few studies have shown that some alternate

strategies used by the dentist have helped in the successful management of hearing impaired children such as usage of some basic signs, actions, models, pictures and videos. [2, 13, 46]

But in most of the studies, the assessment was limited to communication between the dentist and patient during their consultation period. [53, 54] However there is limited data regarding the impact of communication on the hearing impaired children during treatment procedure.

During the recent years, technology and computer advances have influenced the lifestyle of the population. Moreover with the popularity of 'mhealth', which is playing an influential role in medical and public health practices, development of multimedia software programs and mobile applications for health education has been supported by organized policies and activities. One such recent advancement for improving the communication with hearing and speech impaired is the sign language translator application in which English speech or text is converted into signs pertaining to it and displayed on the screen in real-time. The sign language translator application helps the dental professional to communicate with the child in the way they can understand which in turn will serve in the successful management of the hearing impaired children.

Among the sign language translator mobile applications available in the google play store, 'Sanket™' was the only Indian sign language translator

application and it was selected for the study because children in India are trained and use Indian sign language except Andhra Pradesh where regional sign language is used. [11] The present version of the mobile application includes new features which were added to the existing application on our request such as the option of converting speech to sign language, inclusion of many signs pertaining to dentistry, option of converting emoticons into text or speech to facilitate two-way communication. Prior to the study, the updated version of the application was used by the hearing impaired children, teachers and trainers during the dental screening camp and their feedback was obtained. Thus the present study was performed to evaluate the impact of Indian sign language translator application on hearing impaired children during the treatment procedure.

A total of 297 hearing impaired children in the age group of 4 to 13 years were screened in various schools across Chennai of which 154 children required dental treatment. 122 children who reported to the department of Paediatrics and Preventive Dentistry in order to undergo the dental treatment. Among them, 51 children who failed to meet the inclusion criteria were excluded from the study.

The remaining 71 hearing impaired children between 6 to 13 years of age with no previous dental experience who required multiple visits for completion of the treatment were included in this study. This age group was chosen as younger children initially use home sign language which is a form of self-developed

gestural sign language, who are later taught National sign language at their schools. [55] Moreover, parents from low socioeconomic group do not often enroll their children in special schools at an early age, thereby affecting their communication skills. [56,57] Children who had not undergone previous dental treatment were chosen because previous experience can have an influence on one's attitude towards dentistry.

Each child underwent three treatment sessions during which the nonverbal communication was used in the first visit for all the study subjects and oral prophylaxis was done. In the subsequent visits, based on their treatment needs and requirement of local anesthesia administration, the study population were distributed into one of the three groups. The reason for grouping was to assess the effect of complexity of treatment procedure and its role on anxiety and behavior of the hearing impaired children. In the second and third visit, sign language translator application and interpreter were used as a communication mode for all the study subjects in a cross-over manner to nullify the effect on one mode over the other. Thus, all the study subjects were exposed to all the three modes of communication in either of the three visits.

In the present study, behavior of the study subjects was assessed with Frankl's behavior rating scale and anxiety was assessed with facial image scale score and pulse rate as these scales and measures have been accepted and proven

as reliable and valid measures of the child's responses in the dental situation. [2,49] An Independent observer who was a non-operating dentist was assigned to judge the interactions between the operating dentist and the hearing impaired child to rate the level of understanding and ease of communication at the end of each treatment session to avoid the bias. At the end of third visit, child's perception and parental satisfaction was assessed using a questionnaire. Based on their response any further dental treatment required for the children was completed in the subsequent visits using their preferred mode of communication.

The present study's results showed that there was a definite overall significant reduction in anxiety levels of the children during the dental treatment based on both mean pulse rate (table 2) and facial image scale (table 6) scores in all the three groups with three different modes of communication ($P \leq 0.05$).

The significant reduction in anxiety levels noted with nonverbal communication among the hearing impaired children postoperatively might be probably due to the use of some basic actions which would have relaxed the child and promoted trust. Nonverbal communication forms the key aspect of communication even for normal hearing children. Mehrabian (1972) stated that 55% of communication is through nonverbal, only 7% is in words and 35% in vocal elements. It is recommended that the dental clinic team should be able to use non-verbal communication which includes facial expressions, body language

and posture, gestures, paralinguistic, proxemics, haptics and appearance. [8, 10] In the present study, the use of nonverbal communication was limited only to the initial visit during the examination period and for performing oral prophylaxis. The impact of nonverbal communication on child's anxiety and behavior was assessed only for noninvasive procedure, but definitely it had some positive effect on the study population.

The reduction in the anxiety of the hearing impaired children with the use of sign language translator application as a communication aid could be attributed to the fact that the treatment procedure was explained in the way they can understand prior to the treatment and instructions were also given using the application during the treatment procedure. At the same time, they were able to express their thoughts and feelings with the operating dentist during the procedure through the emoticons in the translator application which shows that an element of control and also the means of communication were provided for the hearing impaired children which means that an effective communication was established between the hearing impaired child and the operating dentist. [2] Also, the translator application has an animated character to sign the instructions and involvement of the child in using the emoticons which can act as a visual distraction.

When the sign language interpreter was used to communicate with the hearing impaired children, the anxiety reduction might be due to the fact that since the parent or the caregiver of the child was assigned as an interpreter during their dental treatment with whom they are more associated and comfortable. The drawbacks of using an interpreter are that they should be available in all the appointments, more of indirect communication with the child. Thus it is important to pay attention to the patient when he replies and try talking directly to the hearing impaired child with the assistance of an interpreter. [8]

The reduction in the anxiety levels of the study subjects observed in this study were similar to the findings of **Shalini Chandrasekhar et al**, who reported the reduction in anxiety levels of hearing impaired children by using dentisign during the treatment procedure [2] and **Kausar Sadia Fakhruddin** et al reported the reduction in anxiety levels by using visual distraction technique while performing pulp therapy in hearing disabled children. [46]

Among the study population it was noted that most of them showed a positive behavior prior to the treatment which was similar to the findings of **Shetty et al.** [49] During the experimental period, there was a significant improvement with no deterioration observed in the behavior of the study population from preoperatively to postoperatively with all the three modes of communication. The similar outcome was observed among all the three groups

suggesting that the treatment procedure had no effect on child's anxiety and behavior. This might be because the first and foremost behavior management strategy used by the pediatric dentist is the establishment of an effective communication to build trust, allay fear, and thereby treat the child effectively and efficiently. Moreover, the reduction in anxiety helped in the improvement of behavior among the study population. This was similar to the observation reported by **Navanith Renahan** et al [13] who managed a hearing impaired child by using simple signs, models and pictures thereby instilled a positive attitude towards dentistry. [16]

The observer's rating showed that 70.42% and 67.6% of the study population were very easily able to understand the instructions and communicate with the dentist with sign language interpreter and translator application respectively which shows the establishment of a successful two-way communication with these two modes of communication. Whereas, only 4.22% of the study population were able to easily understand and communicate with nonverbal communication which shows the establishment of a successful two-way communication with sign language translator and interpreter as the transformation of information was restricted and required repetition.

The child's perception questionnaire reveals that 87.3% found it understanding of the instructions easy with the application. 67.7% were able to

communicate with the dentist using emoticons whereas 2.8% had difficulty in understanding and communicating as they preferred other modes of communication. 67.6% preferred translator application whereas 32.4% referred interpreter for communication suggesting an inclination towards the use of translator application during the dental treatment.

The parental satisfaction scores shows that 97.2% of the parents felt that their child was able to cope up with the dental treatment when translator application was used whereas 2.8% felt that the child was able to cope up with the treatment only to some extent which might be due to the complexity of the treatment procedure. 87.3% of the parents felt that the child was able to communicate using emoticons with the sign language translator application whereas 4.2% of them found it difficult which is because of the unfamiliarity of the mobile application. 98.5% of the parents recommend the use of translator application in the future to treat their children whereas 4.2% preferred using the application along with other modes of communication.

The study is limited only to hearing impaired children those who mostly use Indian sign language, thus it requires further evaluation in children who are not trained in Indian sign language and younger children. The sample size is also limited to children belonging to few schools in the same region, therefore, further studies should be carried out in various locations to validate the effectiveness of

the present study design. The translator application requires training and reinforcement before using it in the dental operatory. Assistance is required while using the application as the dentist cannot operate the mobile phone with the gloved hands. There might be a restricted communication with the emoticons, for which the facility of recognizing the signs shown by the child and converting them into text can be more appropriate which is still under research. The animated character present in the application shows the signs only with the hands and fingers without any facial expression which is a part of sign language, therefore the exact emotions might not be expressed to the hearing impaired children. Since the interpreter is a family member or a very familiar person, more ease and comfortability can be noted, which can be a bias when compared with a translator application to which they are newly exposed, thus further assessment can be done by using a professional common interpreter for all the study subjects. Nonverbal communication was used only for noninvasive treatment procedure, further studies evaluating the impact of nonverbal communication on complex treatment procedures requiring local anesthesia is recommended.

Sign language translator application had a positive impact on the hearing impaired children by reducing their anxiety and improving their behavior during the dental treatment which was found to be as efficient as an interpreter and better than nonverbal communication. Thus, the sign language translator application can be used as an adjunct in the management of hearing impaired children in the

dental operatory and it is not meant to replace the interpreter but it can serve as an alternate aid.

Conclusion

CONCLUSION

Within the limitations of this study, it can be concluded that:

1. There was significant reduction in anxiety levels (based on pulse rate and Facial image scale) from pre intervention to post intervention among the study population with all the three modes of communication ($P \leq 0.05$).
2. Communicating with sign language translator application and interpreter showed a positive impact on the anxiety levels of the study subjects when compared to nonverbal communication ($P \leq 0.05$). There was no significant difference in the amount of anxiety reduction between sign language translator application and interpreter ($P \geq 0.005$)
3. There was significant improvement noted in the behavior of the study population with all the three modes of communication ($P \leq 0.05$).
4. A highly significant improvement in behavior was noted when communicated with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$).
5. Similar outcome was observed among all the three groups suggesting that the treatment procedure had no impact on anxiety and behavior of the hearing impaired children with all the three modes of communication.
6. The independent observer's rating scale showed that 70.42% of the hearing impaired children with interpreter, 67.67% of children with sign

language translator application and 4.22% of children with nonverbal communication were able to easily understand and communicate.

7. 87.3% of hearing impaired children felt that they were able understand the instruction easily and 67.6% were able to communicate with the dentist with sign language translator application. 67.6% chose translator application as their preferred mode of communication.
8. 97.2% of the parents felt that the child was able to cope up with the dental treatment and 87.3% were able to communicate using sign language translator application. 98.5% of the parents recommended translator application as a mode of communication in the future.

The study results establish a significantly lower objective and subjective anxiety scores and an improved behavior in all the three groups with sign language translator application and interpreter. Though some change was noted with nonverbal communication it was not statistically significant compared to other two modes of communication. Based on these conclusions it was suggested that sign language translator application had a positive impact on the hearing impaired children by reducing their anxiety and improving their behavior during the dental treatment which was found to be as efficient as an interpreter and better than nonverbal communication.

Thus, the sign language translator application can be used as an adjunct in the management of hearing impaired children in the dental operatory and it is not meant to replace the interpreter but it can serve as an alternate aid.

Summary

SUMMARY

The present study was done to evaluate and compare the efficacy of the Indian sign language translator application with nonverbal communication and sign language interpreter in relieving anxiety and improving the behavior of 71 hearing impaired children during dental treatment. In the first visit, oral prophylaxis was done for all the study subjects using nonverbal communication. Further, the study population were divided into three groups based on their treatment needs, Group 1 included hearing impaired children requiring only restorative procedures, group 2 included hearing impaired children requiring either extraction or pulp therapy and group 3 included hearing impaired children requiring combination of treatment procedures for whom sign language translator application and interpreter were used in a crossover manner in subsequent two visits. Each child's subjective (facial image scale) and objective (pulse rate) anxiety scores, Frankl's behavior ratings and independent observer's ratings in each session were recorded. Questionnaire assessing the child's perception and parental satisfaction were recorded at the end of third visit.

There was significant reduction in the anxiety levels of the study subjects based on mean pulse rate and facial image scale among the study population with all three modes of communication ($P \leq 0.05$). It was found that among the children who underwent treatment using sign language translator application and

interpreter, a definite reduction in anxiety was observed when compared to that of nonverbal communication. A highly significant improvement in behavior was noted when communicated with sign language translator application and interpreter compared to nonverbal communication ($P \leq 0.05$). The observer's rating showed that 70.42% and 67.6% of the study population was very easily able to understand the instructions and communicate with the dentist with sign language interpreter and translator application respectively. 67.6% of hearing impaired children selected mobile translator application and 32.39% selected interpreter as their preferred mode of communication in their future dental appointments. 98.5% of parents recommended the use of mobile translator application during the dental treatment procedure to communicate with their hearing impaired children.

The study concludes that the performance of sign language translator application was equal to that of the interpreter but better than nonverbal communication. Thus it is evident that sign language translator application is not to replace the interpreter but can be used as an alternate in the absence of sign language interpreter while managing hearing impaired children in the dental operatory.

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