Autism spectrum disorder and paediatric dentistry: A narrative overview of intervention strategy and introduction of an innovative technological intervention method



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Abstract

Aim When treating patients with Autism Spectrum Disorder (ASD) the doctor-patient relationship can be very challenging. The dentist is often forced to work under general anaesthesia or conscious sedation. Children with ASD are patients with an increased risk of caries due to poor oral hygiene, a cariogenic diet and the use of xerostomal drugs. In this work therapeutic strategies used to treat this kind of patients are evaluated and a new method to treat children with ASD is presented in order to increase awareness about this condition in the dental field.

Methods The Atlas Center (a non-profit organisation in Peurgia, Italy) has developed a software, called paINTeraction, that allows these special children to immerse themselves in a virtual reality with the help of an operator. Through this system the child can explore the dental office (and all its sounds and noises) before the real dental visit, thus connecting to the dental professional, achieving greater compliance and reducing anxiety.

Results The literature shows that performing treatments on ASD patients is complex due to their insufficient cooperation, communication and behavioural difficulties, and hypersensitivity to sensory stimuli.

Conclusions paINTeraction, with the use of digital technology tools, may be particularly well suited to introduce patients to the therapeutic environment, particularly in the dental setting.

KEYWORDS Autism Spectrum Disorder; Paediatric dentistry; Operative dentistry; Dental treatment; Oral health.

Introduction

Autism Spectrum Disorder (ASD) include different types of symptoms like early-onset neurodevelopmental disorders, difficulties in interaction, verbal and non-verbal communication, narrow interests and repetitive and stereotyped behaviours. Children with ASD exhibit hypersensitivity to external stimuli such as sounds and noises and repetitive and stereotypical body movements such as body rocking, self-stimulation, or hand clapping. They may also show unusual responses, attachment to objects, resistance to changes in daily routines, or aggressive and self-injurious behaviours [McPartland and Volkmar, 2012]. In some cases, the diagnosis of ASD is accompanied by other disorders, such as Attention Deficit/Hyperactivity Disorder (ADHD) or a psychopathological impairment (mood, anxiety, sleeping and eating disorders) [Arberas and Ruggieri, 2019].

Today many diagnostic tools are available to allow the diagnosis of ASD to be made as early as the child is two years old. Epidemiological data show that in recent years the increase in the prevalence of ASD has been significant; it does not seem to be a geographical and/or ethnic prevalence, but rather a gender prevalence, with an M:F ratio of approximately 4:1, and an estimation of 1 in 54 affected children in the United States [Johnson and Myers, 2007]. In Italy, according to data from the National Observatory for Monitoring Autism Spectrum Disorders, 1 in 77 children (aged 7–9 years) presents ASD with a higher prevalence in males, who are affected 4.4 times more than females [Battagoni et al., 2021]. The increase in the prevalence of ASD is the result of better and earlier screening of the disorder and improved diagnostic techniques, as well as greater awareness among professionals and the general population. Thanks to this progress, it is possible to identify ASD at an early stage, even in its mildest forms; preventive interventions can thus positively modify the child's symptoma profile, reducing behaviours that lead to social isolation. Social isolation is the main trait of these patients, which also determines the difficulties related to health care.

The diagnosis is clinical and based only on observation of the child. There are no laboratory or imaging exams that can confirm the diagnosis. It is therefore recommended to rely on specialised healthcare facilities and a multidisciplinary team, consisting of a child neuropsychiatrist, a psychologist and a speech therapist. Specific tests are carried out to make a diagnosis: the Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2) and the Autism Diagnostic Interview- Revised (ADI-R). In the diagnostic phase, it is essential to investigate, in addition to the symptoms linked to autism, the child's cognitive functioning, adaptive behaviour and linguistic abilities [Bhat et al., 2014; González et al., 2019].

Several studies have already shown that autistic subjects belong to a vulnerable group that is more exposed to the risk of developing oral pathologies: a significant caries prevalence index has been identified in children with ASD, compared to children with typical development [Bagattoni et al., 2020]. Poor

oral hygiene is certainly among the causes. Children with ASD often lack manual dexterity to brush their teeth properly and also seem less cooperative with their parents in undertaking the daily oral hygiene routine, with poor and irregular brushing. Children with ASD may also have a greater sensory aversion to the taste of toothpaste and the feel of a toothbrush in the mouth [Stein et al., 2011]. In addition, children with ASD may have more caries due to a cariogenic diet. Firstly, because children with autism may prefer cariogenic foods, particularly sugary foods. Furthermore, caregivers often use cariogenic foods (candies and snacks) as a reward during specialised training and interviews, as a positive reinforcement of good behaviour. In addition, children with ASD tend to hold food in their mouths for a prolonged period instead of swallowing, due to poor tongue coordination, increasing the exposure of oral bacteria to carbohydrate sources and therefore the risk of caries [Onol and Kırzıoğlu, 2018].
Finally, another possible explanation for the high incidence of dental caries in children with ASD is the use of xerostomic drugs to manage symptoms. Antidepressants, antipsychotic drugs and psychostimulants, the first choice in the treatment of autism, can cause xerostomia [Capp et al., 2010]. Preventive oral care provided by health services is often not guaranteed for individuals with ASD. A person with ASD is considered vulnerable as dental care, especially public, is limited, further contributing to the worsening of oral health. This leads to inequalities regarding the right to health protection and equal access to basic care [Kuter and Guler. 2019]. Good oral health might be hard to achieve in people with ASD. It is often not easy to convince an individual with autism to follow the correct rules of dental hygiene or to undergo dental care, as their behavioural syndrome prevents the patient from assuming a cooperative attitude towards the health professional. The dental care environment is very hard for a person with ASD, and access to medical care is not part of the child's daily routine. In addition, the dental office presents other critical aspects that stimulate, with a negative effect, the sensory abnormalities that the child with ASD may present: the light is often too bright, the rotating instruments and suctioning are particularly noisy and the direct contact between the dentist and the child during the visit represents a potentially traumatic event [Delli et al., 2013]. The uncooperative and negative behaviour of autistic patients does not allow easy operations and intervention; therefore the most commonly used operative techniques are general anaesthesia and sedation [Schnabl et al., 2020]. To date, there is a lack of specific protocols for these patients in order to improve their cooperation and consequently their oral health.
In the present study, after a review of the treatment strategies of individuals with ASD in the literature, we identified a possible operational approach based on innovative and technological tools. This new approach allows the training of the individual with autism prior to dental treatment. The approach involves the use of an augmented reality tool in an art-therapy setting on individuals with autism. The possible and forthcoming application of the approach could ensure standards of care for one of the most vulnerable groups such as individuals with ASD, with particular reference to the degree of accessibility to dental care. The aim of this study was to provide clinical guidance in the treatment of ASD children.

Materials and methods

Study design

In this article, an analysis (narrative overview) of the most current scientific evidence was carried out to understand the main strategies and techniques of dental treatments in children with autism. As the aim of this study was to provide clinical guidance in the treatment of autistic children, the results section was not structured in a traditional design, but as the presentation of an innovative interventional approach.
A comprehensive search of the published English literature was conducted in PubMed- Medline until June 2021, using the following Mesh terms: ((("Pediatric Dentistry"[MeSH Terms] OR "Dentistry"[MeSH Terms] OR " Oral Health "[MeSH Terms] OR " Mouth Diseases "[MeSH Terms])AND ("Autistic Disorder"[MeSH Terms] OR "Autism Spectrum Disorder"[MeSH Terms] OR "ASD"[All Fields] OR "ASD syndrome"[All Fields])) AND ("child"[MeSH Terms] OR "child"[All Fields] OR "children"[All Fields] OR "child*"[All Fields] OR "Child, Preschool"[MeSH Terms])) NOT (Systematic Review [Publication Type] OR Review [Publication Type] OR Meta-Analysis [Publication Type] OR Comment [Publication Type] OR Congress [Publication Type] OR Editorial [Publication Type] OR Clinical Conference [Publication Type] OR Comment [Publication Type] OR Consensus Development Conference [Publication Type]). Two of our investigators independently searched the database (M.C and C.A) and reviewed each of the retrieved articles.
The search strategy in the selected database yielded a total of 311 articles. Overall, 194 articles were excluded after the evaluation of the title and abstract according to the inclusion and exclusion criteria. There were 76 duplicate references. Thus, 41 articles were finally available for the full-text examination. The evaluation of these articles in full resulted in the selection of 14 studies. The innovative interventional approach test aims to explore and evaluate the reaction and responsiveness to specific digital tools by a population with autism in a dentistry facility with an art therapy setting. Qualitative research could be carried out to assess reactions through direct observation of acceptance or avoidance of the proposed treatment and activities during the dentistry session.
The study aims to address both how subjects with autism experience digital technology as a clinical intervention in art therapy, and which technological tools in an art therapy setting improve opportunities to establish a relationship with therapists.

Studies selection and data extraction

The research strategy was divided into two parts. The first part focused on ASD patients analysis and dental procedures; the main criterion was to identify the most recent studies published in the most popular international journals. No limitation was adopted in the selection of the studies. The results of this research are described as "General criteria of dental procedures in patients with ASD" in the Results section.
The second research strategy focused on analysing the management ASD patients during the dental visit and the strategies used for dental care. A number of *in vitro* studies were consulted to strengthen the data published in the clinical studies. The data were included in the Results section as "Specific safety criteria". Pubmed, Embase and Web of Science databases were accessed, as well as the Cochrane Oral Health's Trials Register and the Cochrane Central Register of Controlled Trials (CENTRAL; 2019) in the Cochrane Library.
Useful records for our analysis found in the literature were read in full-text and data were extracted. Two researchers (M.C. and C.A.) independently performed record selection and data extraction. Any disagreement between the researchers were solved through discussion, with the involvement of a third researcher (S.P.).

Inclusion and exclusion criteria

No type of study design was excluded, although great importance was given to articles with more scientific evidence in relation to the study design. The clinical protocols presented in the studies were also assessed. Studies dealing with pre-school children (up to 71 months) were preferably selected, but the age of the study participants was not an exclusion criterion. Only studies in English language were considered. The Inclusion criteria are papers published in English, with no time restrictions on publication date; studies with preschool child or child population with ASD syndrome and papers investigating all types of dental treatment in ASD patients. The exclusion criteria are articles with patient populations other than ASD syndrome; Articles that do not investigate dental therapies in ASD patients and Studies with no full-text available, review articles and meta-analyses, editorials, opinions, guidelines, conferences, commentary articles.

Outcomes

Primary outcome: dental treatment strategies for patients with ASD. Secondary outcomes: dental anxiety for patients with ASD, oral health in patients with ASD, parents' perception of oral health.

Statistical analysis

The effectiveness of the management of patients with ASD during the dental visit and the strategies used for dental care in the studies selected were described with the following relative indices: Odds Ratio (OR), Risk Ratio (RR) or Prevalence Ratio (PR) with a 95% confidence interval (CI) for dichotomous outcomes between the treatment group and the control group; when continuous data were described, the mean difference (MD) with a 95% CI was used.

Results

General criteria of dental procedures in ASD patients

Several studies in the recent literature have investigated how autistic patients access dental care and what means and/or what strategies are used to treat this kind of patients.

Some studies have evaluated the approaches of health professionals and dentists to improve dental performance. One study stated that dental visits are successful due to the scheduling of visits, collaboration with other professionals in teams and the application of individualised care. In addition, successful treatment is achieved by using joint strategies between parents and dentists, such as the use of educational materials to enable more effective and efficient dental treatment and to prepare children with ASD for dental visits. Moreover, parents report other strategies used by practitioners in clinical practice: the flexibility and willingness of the practitioner to personalise the visit and the collaboration with other professionals to train dental staff on the characteristics of the patient with autism [Stein Duker et al., 2019].

Several studies have proposed home-based educational and/or technological strategies as supporting material to prepare children with ASD for dental visits. Fenning et al. [2020] proposed the creation of a home-based doctor model through educational support materials such as books and digital APPs to facilitate access to facilities and treatment success.A pilot study (randomised and controlled) by Isong et al. [2014] shows that the use of technology in preparation for visits through devices such as smartphones, tablets and PCs can decrease fear, anxiety and uncooperative behaviour in children with ASD. Some children also benefited from an early meeting and step-by-step planning approach. To date, technology, particularly in relation to visual pedagogy, is presented as a new approach to improve dental care in children with ASD. In a systematic review, the effectiveness of using visual pedagogy to improve oral hygiene skills and cooperation during care in patients with ASD was evaluated. The study stated that the use of visual pedagogy improved both oral hygiene skills and cooperation during dental care [Balian et al., 2021]. Cagetti et al. [2015] proposed a dental care protocol based on visual aids to help children with ASD complete a dental examination and treatment. The use of visual aids facilitated treatment even in non-verbal children with low intellectual levels, underlining how the behavioural approach should be applied as a first strategy to treat patients with ASD in the dental setting. Furthermore, the protocol included the collaboration of parents, who performed the training on their children at home after being trained. The role of parents in this protocol was therefore crucial. This confirms that not only acting before the visit with educational material allows the success of the dental visit, but also how important the collaboration between professionals, caregivers and families is in order to successfully achieve the goals. Success depends very much on the collaboration and training of parents and/or caregivers [Cagetti et al., 2015]. Another study, conducted by Nilchian et al. [2017], evaluated the impact of visual pedagogy in dental visits among children with autism aged 6–12 years. The results of this study showed that visual pedagogy was only useful in fluoride therapy. Furthermore, the study demonstrated that increasing the frequency of visits significantly increased the children's co-operation, such as entering the office, sitting down, opening their mouth and being examined with the visit kit (mirror and probe). A study conducted on a group of Saudi Arabian children with ASD evaluated the effectiveness of using a picture book as a preparatory support during the first dental visit. Approximately 50% of the children had positive behaviour during the visit and the use of the book had a positive effect on the children's behaviour. A follow-up survey also suggested an improvement in parents' dental knowledge and oral hygiene practices [Murshid, 2017]. Preparing the patient for a future visit is therefore crucial for the success of the treatment and should be done early by both the practitioner and the family. Another study confirms the positive effects of peri-operative dialogue between parents and health professionals [Vlassakova and Emmanouil, 2016].

The dentist must also work with the treating physicians to understand which events are distressing or frightening for the child with ASD, in order to decide which strategies might work properly for each particular situation. Thus, there is a need to use "subjective" intervention strategies and adapt strategies to the variables of the individual patient [Kuhaneck and Chisholm, 2012]. The creation of a multidisciplinary patient-dentist-caregiver-family intervention model would increase collaboration and compliance of dental services, both in terms of prevention and intervention. The success and delivery of dental care and dental visits should be managed by educational and behavioural approaches performed by a multidisciplinary team [Nelson et al., 2015]. The dentist should be involved in a team to educate the patient and assist him/her in oral hygiene practices, thus avoiding invasive dental treatments, which are quite difficult to perform on such patients. Numerous studies show that general anaesthesia or sedation are sometimes the only solutions for performing treatments on these patients. General anaesthesia is preferred by dentists and is the most widely used [Friedlander et al., 2006]. Mangione et al. [2020]

stated that in a sample of subjects suffering from ASD, all dental treatments were performed under anaesthesia or conscious sedation. Very often, the peculiarity and variability of autism spectrum disorders complicates the definition of precise guidelines to carry out dental treatment on these subjects without having to resort to drug therapy. However, individuals with autism have an increased need for preventive oral health care due to sensory and compliance issues in performing daily oral hygiene procedures.

Innovative interventional approach test: paINTeraction

paINTeraction technology is an intervention model for individuals with severe and/or multiple disabilities based on the use of augmented reality. paINTeraction was designed in 2015 by Simone Donnari, at the Atlas Centre in Perugia, Italy (www.atlascentre.eu - https://www.youtube.com/user/simo4444). The PaINTeraction setting is made of a television screen, a personal computer and a motion sensing input device. In Augmented Reality (AR) virtual elements are used to build upon the existing environment. Customers can see their own body in an imaginary context while feeling inside the "real" world. The TV screen works like a mirror, reproducing the real room where the action happens, with AR that enhances the real world by giving a visual feedback of movements.

paINTeraction actively involves the therapists in the activities, using technology to promote the development of relationships. In each session you can choose one of the five applications offered by the software.

1. Trails: the movement of the user's hands creates light trails on the screen, with the possibility of associating a sound to this movement, promoting sensorial integration.
2. Paint: with the movement of the hand the user can draw "freehand" on the selected background, being able to choose the color and type of stroke. Sensorimotor integration stimulates symbolic-figurative language.
3. Physics: it allows an interaction by means of a virtual ball that bounces in response to body contact. Through the game, motor coordination and interaction with the operator is stimulated.
4. Vowels: vowels emitted by the user are detected and converted into colored shapes. The software recognises the sound and visual properties of the user's mouth while emitting the sounds in real time, reproducing on the screen images with physical properties and visual shape similar to the mouth movement required to produce such sound.
5. Avatart: after choosing a background (one's own drawing or a chosen image), the client can see his/her own body immersed in the image. A detail of the image or a favourite character can be used as a personalised avatar and can be moved by one's own body. It can be used for storytelling or as a real-life simulation tool.

The paINTeraction method was used in 2018 for a pilot study in cooperation with the Istituto Serafico, Assisi (Perugia) in a severe/multiple disability context. The results of the study affirmed that the paINTeration tool introduced in the art therapy setting was easily accepted by most of the subjects involved and generally allowed the development of a therapist-patient interpersonal relationship [Donnari et al., 2019; Pazzagli et al.,2018].

PaINTeraction and paediatric dentistry: intervention strategy on paediatric patients with ASD

Following this study and the knowledge of the paINTeraction project, the idea and the need to apply the potential of augmented reality in the medical field, in particular in dentistry, has come up. The project "paINTeraction e odontoiatriapediatrica" (paINTeraction and paediatric dentistry), which involves the collaboration between the University Dental Centre (C.O.U.) of Perugia and the Atlas Center, aims to create and promote an operational intervention on patients with ASD. This project aims to evaluate whether the interaction between a patient with special needs, like a child with ASD, and the dental environment, reproduced in augmented reality within a "safe zone" such as the Atlas Center, can reduce the emotional stress generated by the dental visit, with the ultimate goal of improving the oral hygiene and dental performance of the child. In particular, using augmented reality, the child can immerse himself inside the dental office, get to know in advance the setting where the visit will take place, familiarise with the characteristic noises of the environment, meet the operators and the instruments that will be used before the real visit takes place.

The project will be divided into five phases as follows.

- Phase 1 - Staff Training: based on the fundamentals of psychomotor therapy and art therapy, which are the basis of the paINTeraction project, it is essential to provide adequate training to the health care providers involved in the project on ASD and the cognitive-bahavioural techniques to be adopted, so that they can become active co-therapists. The staff also needs to be aware of the most common dental conditions in patients with ASD and the adverse bahaviours that can occur in the dental environment. Finally, a thorough understanding of the concept of art therapy and paINTeraction is essential so that all the experimenters involved can use these techniques at the best of their ability.
- Phase 2 - Participation of the dental staff in the art therapy sessions: the second phase involves the interaction of health workers with the children and young people with ASD recruited in the project, at the Atlas Center. During the Art Therapy sessions, the operators will interact with the children, actively collaborating in the use of the software, creating for example drawings that can then be used as background into the paINTeraction software. The child, on the other hand, can begin to know and interact with the operator, gradually getting used to his/her presence.
- Phase 3 - Collection of sounds, lights and images of the C.O.U. by the operators of the Atlas Center: in this phase, the operators of the Atlas Center will record sounds, lights and images of the C.O.U., where effective dental sessions will take place. The audio-visual recordings will then be inserted into the augmented reality system and will faithfully reproduce the dental environment. This will be a fundamental step to allow the immersion of the child with ASD, who will know in advance the dental office and become familiar with it and the surrounding environment (Fig. 1).
- Phase 4 - Augmented reality and interactive simulation of the future specialist visit: this phase consist of several sessions involving health workers and children at the Atlas Center. During these sessions the healthcare professionals, together with the referring therapist, will use the augmented reality simulation of the paINTeration to allow the child to visualise, through mirroring, not only him/herself but also the healthcare professionals and interact with them (Fig. 2). Seeing on the screen the interaction between health workers and the patient with ASD, beside increasing their empathy, may also improve the interaction quality during the dental examination. During the paINTeration sessions, images of the C.O.U. will be used as a background where the child can

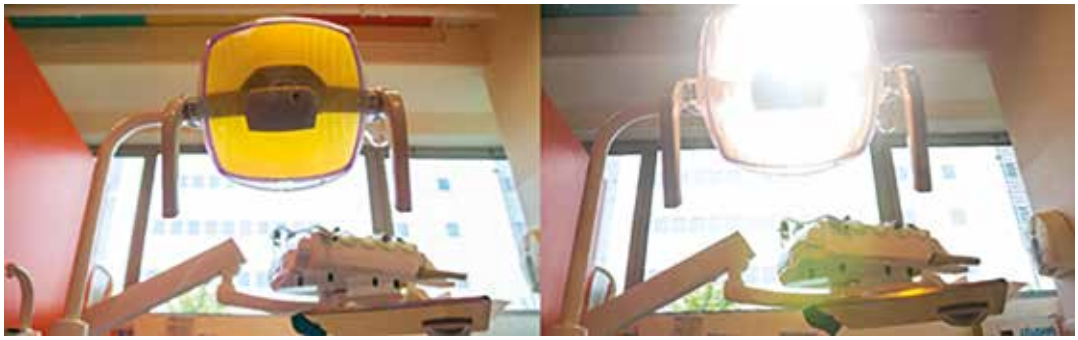


FIG. 1 Image of the dental unit light that the patient can observe and experience during pre-visit sessions.

virtually play and move. Different images will be projected in order to represent the different spaces of the C.O.U. and to allow the child to know and fully immerse him/herself in the structure.

- Phase 5 - Specialist visit at the C.O.U.: during the first visit, the child will find the environments he/she has known during the virtual experiences thanks to the paINTeraction augmented reality simulation, as well as the healthcare personnel with whom he/she had interacted during the Art therapy and paINTeraction sessions, including the Atlas Center operator and his/her parents.

The primary goal of the dental visit is to establish trust and develop a relationship with the child with ASD. Therefore, it is necessary to avoid trauma or unpleasant experiences for patients with ASD, by organising the dental visit as follows.

1. Sessions should be well organised and waiting times should not exceed 10–15 minutes, to prevent children with low attention spans from becoming agitated.
2. Appointments are set in a specific order so that the dental session becomes part of the child's daily routine.



FIG. 2 The patient with ASD is immersed together with the health care provider/caregiver in the dental environment and the examination that will be performed in the future is simulated.

3. Movements by dental staff should be kept to a minimum, and all materials needed for the visit should be prepared before the patient is seated, as the child with ASD is prone to be easily distracted, which could compromise the results of the visit.
4. Dental staff should be trained to identify the triggers of aversive reactions in children with ASD, and avoid, for example, bahaviours or objects that may trigger aggressive bahaviour, ruining trust with the facility and the work plan.
5. Parents should fully report the child's medical and dental history. It is also essential that parents report previous dental experiences to the dentist in order to identify not only dental problems, but also aversive behaviours.

For the purposes of the research it will be important to observe how many of the children present in the project show a certain degree of compliance with the operator during the dental visit. The positive attitudes will be detected following a template of observation of behaviour (Table 1), which evaluates the behaviour shown during the visit and the reactions of the child to the treatment.

The higher the score, out of a total of 13 points (Table 2), the more the child is available and willing to accept the contact with the health worker and the dental procedures. On the contrary, a low score (less than 6 points) shows the presence of aggressive, stereotyped bahaviours, episodes of anger and refusal in the interaction with the dentist. Monitoring is done by assigning each bahaviour a score of 0 or 1, depending on the response assigned. Comparing the graphs after each visit will provide data on the improvement, worsening or constancy of the interactions and bahaviours of the child.

Discussion

Autism (WHO classification ICD 10 and DSM IV) is considered by the international scientific community as a pervasive developmental disorder, manifesting from the age of three with deficits in the areas of communication, social interaction, and imagination. ASD can be a major obstacle in achieving good oral health and hygiene. It is not easy to convince a patient with ASD to follow proper dental hygiene practices or undergo dental treatment, as the syndrome is bahavioural in origin and prevents the patient from taking a cooperative attitude toward the caregiver [Bagattoni et al., 2020]. ASD has become a public health issue, as it appears to be an increasing disease in recent decades. The complexity and variety of clinical manifestations related to this disorder account for the limited cooperation of patients during dental procedures. Therefore, patients with ASD, among all patients with special needs, represent a real challenge for dentists [Stein et al., 2011].

Our study aimed at creating an overview of the dental

Behaviour observation grid during dental visit with patient with Autism Spectrum Disorders (ASD)

Name_____Surname_____-_____Visit date_____
Type of interaction

1.	The child sits in the dental chair without any problems	Yes ❑ No ❑
2.	The child opens his/her mouth independently	Yes ❑ No ❑
3.	The child accepts the mirror and the probe in his/her mouth	Yes ❑ No ❑
4.	The child accepts hand and rotary tools	Yes ❑ No ❑
5.	The child interacts affectionately with the dentist, is curious about the procedures	Yes ❑ No ❑
6.	The child accepts even the most painful treatment	Yes ❑ No ❑
7.	The child jumps and drops to the floor, refusing to sit in dentalchair	Yes ❑ No ❑
8.	The child is screaming, crying, cursing loudly in a state of strong agitation	Yes ❑ No ❑
9.	The child continues to implement stereotypies (e.g., rocking, clapping hands, rocking head, moving objects), preventing treatment	Yes ❑ No ❑
10.	The child feels disinterested and does not follow the instructions of the dentist	Yes ❑ No ❑
11.	The child responds to contact with the dentist with a violent attitude (punching, slapping, kicking, yanking, pushing, head-butting, pinching)	Yes ❑ No ❑
12.	The child violently uses objects around him/her, directed at other people (e.g. hurls objects on the dental unit, tries to use them as a weapon, spits)	Yes ❑ No ❑
13.	The child does not talk to the dentist and stays close to his/her caregivers or to the operator of the center	Yes ❑ No ❑

TABLE 1 Observation grid for the behaviuor of the child with ASD during the dental visit.

Question number	Score
1.	Yes = 1 No = 0
2.	Yes = 1 No = 0
3.	Yes = 1 No = 0
4.	Yes = 1 No = 0
5.	Yes = 1 No = 0
6.	Yes = 1 No = 0
7.	Yes = 0 No = 1
8.	Yes = 0 No = 1
9.	Yes = 0 No = 1
10.	Yes = 0 No = 1
11.	Yes = 0 No = 1
12.	Yes = 0 No = 1
13.	Yes = 0 No = 1

TABLE 2 Score resulting from the completion of the behaviour observation template during the visit.

aspects of patients with autism, both in terms of related clinical manifestations and in terms of therapeutic approach. The results obtained show a good level of knowledge of the problem and its repercussions on the oral cavity. For individuals with ASD, dental treatment represents an aversive experience, external to the daily routine they are familiar with. Performing treatments on these patients is complex not only because of their insufficient collaboration, but also because of communication and bahavioural difficulties and hypersensitivity to sensory stimuli. Patients with ASD who require dental treatment are unlikely to tolerate treatment because of all these problems. Cognitive dysfunction, restlessness, seizures, and other autistic disorders limit or prevent to carry out treatment under conventional conditions. Sometimes the use of drug therapies seems to be the only solution. In addition, the limited availability of dental specialists trained to serve these patients with special needs can also complicate access to oral health services [Schnabl et al., 2020]. Patients with autism are therefore subject to an increased risk of developing oral cavity diseases, either due to improper hygiene, or due to factors that lead to the development of caries such as the predilection for sweet and cariogenic foods and the intake of xerostomic drugs. All of these factors lead patients with ASD to require specific dental care and treatment protocols. The use of general anaesthesia, particularly intravenous anaesthesia, has so far proven to be the best method to facilitate and enable dental treatments. Not only does this procedure require full cooperation between the dentist, the anaesthesiologist, and the chairside assistant, but it is not devoid of complications: in the postoperative phase, nausea and vomiting occur frequently and are particularly challenging in individuals who have communication difficulties. In addition, postoperative anaesthesia can cause aspiration pneumonia or dehydration. The negative bahaviours of patients testify the need of protocols specifically designed for individuals with ASD in order to improve their cooperation and consequently their oral health. The relationship between the family and the practitioner should be one of maximum cooperation. The dentist must carry out a careful interview with the family, including gathering as much information as possible about the patient's behaviour, their likes and dislikes, their preferred activities, triggers for negative behaviour, modelling and coping techniques. The use of different psychological behaviours and techniques is thus crucial. Dental professionals treating patients diagnosed with ASD will need to provide oral health care based on a detailed family-centred approach and unique medical management, including a comprehensive understanding of parental concerns and preferences, the patient's problem behaviours and related comorbidities and needs. This can serve to improve treatment planning and oral health management for patients with ASD [Gandhi and Klein, 2014].

However, there is still need to investigate possible approaches that can implement prevention strategies in patients with ASD. In particular, at present there is no intervention protocol that the dentist can apply to treat this kind of patients. This study represents the first attempt to report a possible therapeutic approach. Recent literature shows the need to create intervention strategies to increase participation and involvement in dental procedures for children with ASD and their caregivers [Delli et al., 2013]. There are studies that have attempted to address this need, showing that the most recent

and widely employed strategies use visitation pedagogy, as evidenced by the studies of Isong et al. [2014] and Cagetti et al. [2015]. Further applicable strategies are clinical: in addition to educational materials, represented in this study by technological support equipment, innovative materials capable of improving and speeding up sessions or minimally invasive operative tools such as lasers could be used in dentistry [Chieruzzi et al., 2014; Valenti et al., 2021]. An advantage of paINTeraction is its potential applicability in different areas of healthcare treatment by modifying the virtual setting shown to the patient.
Limitations of the study: a descriptive review of the literature, although detailed, does not follow the canons of the systematic review. The study is based on an operational protocol and not on a clinical trial whose outcomes have been clinically verified. Limitations of technology: the strategy involves a multidisciplinary intervention consisting of a phase preceding the dental examination that must be carried out in specially equipped centers. Moreover, there is a need for specialised personnel (e.g caregivers, psychologists, psychiatrists, computer technicians). Another aspect to be taken into account is the non-predictability of the results given the extreme novelty of modern augmented reality techniques, whose clinical outcomes are not yet fully defined in terms of efficacy.

Conclusion

The present study provides an opportunity to test new digital tools in the context of special needs and to observe the enormous potential of technology to allow patients with ASD to learn about the dental environment before the first visit itself and to facilitate the doctor-patient relationship. Art therapy through the use of digital technology tools may be particularly well suited to introduce patients to the therapeutic environment, particularly in the dental setting, by reducing anxiety and fear towards a new and challenging environment.

Author contribution

SD and SC conceived idea. SP, SD, CA and SC designed the project. MC and CA collected data; MC, VC and SP contributed to analysis. MC, GL, VC and GL lead the writing. All authors read and approved the final manuscript

Conflict of interest

The authors declare no conflict of interest.

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