



## Autism Spectrum Disorder in Children: Behavioral, Sensory and Gastrointestinal Considerations and Assessment of Oral Health

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### Abstract

Pediatric dentists have an important role in the care and maintenance of oral health for children with Autism Spectrum Disorder (ASD). The primary goals of dental care are to maximize oral health and function, and to help facilitate understanding of the primary features of ASD with families and other medical and dental providers. To assist oral health professionals in the understanding of autism and associated comorbidities, this report reviews the medical presentation of patients with autism and implications for dentistry. We describe the physiological, behavioral, sensory and gastrointestinal considerations of ASD, as well as associated medical conditions, pharmacologic and non pharmacological behavior guidance, and dental considerations for the management of patients with autism. Optimization of oral health is more likely when providers understand the context of patients who present with autism and are able to educate families, guiding them toward effective interventions for health.

**Keywords:** Autism spectrum disorder; Children; Behavioral; Sensory and gastrointestinal considerations; Pediatric dental and oral health

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### Introduction

Autism Spectrum Disorder (ASD) is a set of lifelong neurodevelopmental disorders defined by deficits in social and verbal communication with repetitive and stereotyped behaviors. Onset occurs during early childhood, with symptoms beginning at six months of age and becoming established by age two or three years [1]. ASD is characterized by a set of core deficits, including impaired communication and social interaction, and repetitive stereotyped patterns of behaviors or interests [2].

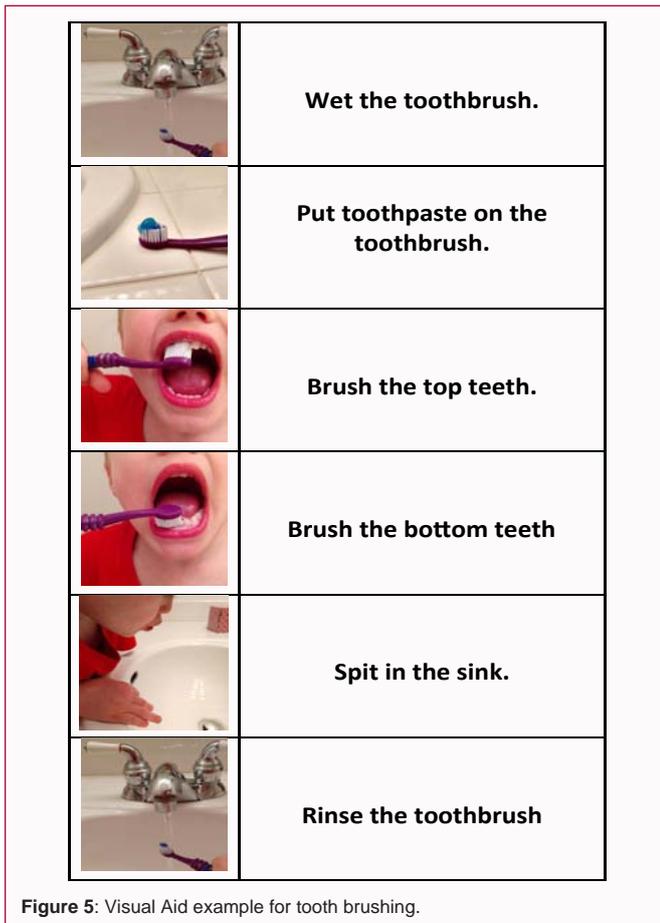
ASD is a spectrum of symptoms on a continuum of severity ranging from mild to severe. This spectrum includes Autistic disorder, Asperger syndrome, and Pervasive Developmental disorder not otherwise specified. Guidelines for diagnosing ASD are found in the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5). DSM-5 states diagnostic criteria within two domains:

1. “Persistent deficits in reciprocal social communication/interaction” and
2. “Restricted, repetitive patterns of behavior, interests, or activities” [3].

The severity of the diagnosis is further detailed into three levels:

1. Requiring support,
2. Requiring substantial support,
3. Requiring very substantial support.

Additional diagnoses are made if a patient presents with or without intellectual impairment, language impairment, or any other known medical, neurodevelopmental or behavioral disorder [3]. The DSM-5 reclassified Asperger’s disorder as a high-functioning form of autism due to those



diagnosed having average to above average intelligence while sharing clinical features with autism [4]. In 2016, the Centers for Disease Control and Prevention reported the prevalence of autism to be 1 in every 68 births in the United States, with 4 times as many males affected as females [4].

### Intellect and Abstract Reasoning

Epidemiological studies have reported below-average intelligence scores (IQ) in approximately three-quarters of individuals with autism. Two-thirds of these individuals demonstrate an IQ of less than 70, placing them in the range defined as having intellectual disability [5]. Children with ASD demonstrated poorer performance relative to typically-developing individuals in response inhibition, vigilance, working memory, flexibility, and shifting of tasks [6]. Nation et al. [7] reported 65% of subjects with autism demonstrated reading comprehension substantially below (>1 standard deviation) population norms, and about one-third exhibited very severe reading comprehension impairments.

Dawson et al. [8] suggested that some individuals with high functioning autism had superior abstract reasoning ability, abstract thinking, pattern identification, problem solving, and discernment of relationships when compared to typical individuals. Of the individuals assessed by Hayashi et al. [9], participants with high-functioning autism performed better than typically developing individuals when tested for abstract reasoning ability and fluid intelligence. This level of reasoning may not persist, as multiple studies report that children with ASD experience decreased executive functioning with aging [10].

### Physical Movement and Motor Deficits

Dyspraxia, a brain-based condition that negatively affects planning and coordination of physical movement has been reported consistently in children with autism. This condition may contribute to impaired motor control and imitation of skilled gestures, ultimately affecting an individual’s posture, balance, speed, coordination, reaction time and grip strength [11]. Difficulty performing skilled motor gestures is one commonly reported trait in children with autism [12]. Impaired performance of skilled gestures has been suggested as contributory to abnormal social development and communication [11].

Motor deficits associated with autism can be identified in infancy, and may be associated with abnormalities in perception of biological motion as well as the favoring of proprioception over visual feedback when learning motor skills [13]. Generalized praxis deficits noted in high functioning children with autism are not limited to imitation gestures, and may be associated with anomalies in the frontal/parietal-subcortical circuits involved in learning and execution of sensory representations of movement [12]. Serdaravic et al. [14] investigated the association of infant neuromotor development with traits of autism, and demonstrated a modest association between overall neuromotor delay early in life and signs of autism in school age children. Neuromotor functioning during infancy is a valuable gauge of central nervous system development. Therefore, motor problems, especially hypotonia, detected in early infancy are a valuable part of screening for ASD [14].

### Language and Verbal Communication Skills Deficits

Language abilities are highly variable in individuals with autism [15]. Joseph et al. [5] described uneven cognitive development in children with autism, with verbal skills more affected than nonverbal skills. When comparing subjects with similar IQ, individuals with autism often demonstrated more impaired language skills than typically-developing individuals [15]. Communication impairments can affect both expressive and receptive language abilities. 33-50% of children with ASD never develop functional speech, and those who have verbal skills tend to have delays in language acquisition [16].

As early as the first year of life, before the emergence of spoken language, signs of social and communication disruption may be detected in children with autism. By 18-24 months of age, five core social communication deficits are detectable: “gaze shifts, gaze point follow, rate of communication, acting for joint attention, and number of gestures” [17,18]. By the second and third years of life, communication is impaired by reduced frequency and diversity of babbling, gestures, and use of consonants in syllables, in addition to the use of unusual words or word combinations [19]. Wetherby et al. [20] described a screening checklist for healthcare providers as best identifying children under age 24 months with autism in the areas of lack of conventional play with a variety of toys, failure to vocalize with consonants, lack of pointing, and lack of response to contextual cues.

### Brain Development and Neural Processing in Autism Spectrum Disorder

Autism is characterized by the comprehensive dysfunction of the association cortex, which comprises most of the brain’s cerebral surface and is chiefly responsible for complex processing linking sensory cortices and behavior [21]. This region’s dysfunction results

in irregularities in multifaceted behavior, language, and cognition [22]. Recent craniofacial studies of individuals with autism noted the common finding of increased head circumferences. Studies of head circumference in autism established a group mean head circumference at the 60<sup>th</sup> through 70<sup>th</sup> percentile in relation to typical norms, which was disproportionate in consideration of height and weight [23]. An increase in total brain volume has been confirmed using magnetic resonance imaging and was recognized in children starting between the ages of 2-4 years [24].

ASD has established associations with increased seizure frequency, epilepsy, and sensory hyper-reactivity. Shifts in cortical excitability affect sensory function due to the dependence on the dynamic accuracy of the excitatory and inhibitory balance to distinguish neural signals [25,26]. Evidence proposes that the pathway involved in cortical excitability is associated with impairments of specific aspects of inhibitory Gamma-Aminobutyric Acid (GABA) neurotransmission. GABA is the primary inhibitory neurotransmitter synthesized from the excitatory neurotransmitter glutamate [27].

### Sensory Abnormalities and Pain Tolerance

Somatic sensory perception and emotional reaction affect pain sensitivity or tolerance. Abnormal touch sensitivity, proprioception, and painful stimuli are characteristics that have been described in individuals with ASD [28]. Using well-controlled stimulations, it has been suggested that individuals with ASD are hyposensitive to pain. Riquelme et al.[29] assessed somatosensory function in the face and hands, as well as upper limb motor function in children with ASD, and demonstrated lower pain threshold and higher tactile sensitivity at the face and hand dorsum compared to typically-developing children. Furthermore, children with ASD had a decreased capability in object manipulation and expressed poorer upper limb proprioception. The high pain sensitivity may be attributed to an abnormality in processing of the affective component of pain mediated by C-fibers. This study demonstrated the impairment of tactile and pain thresholds in children with ASD, supporting the notion that abnormal processing of the affective-motivational dimension of touch may be contributory [29].

### Genetic Basis of Autism Spectrum Disorder

Numerous familial studies over several decades demonstrate the heritability of autism spectrum disorder. Twin studies provide estimates of the genetic contribution to ASD, exhibiting 76-88% concordance for ASD in monozygotic twins and 0-31% in dizygotic twins [30]. The recurrence risk of ASD in siblings is approximately 20% [31]. ASD shows great etiological and clinical heterogeneity, complicating the determination of a genetic basis of the disorder [32]. Symptoms present as behavioral manifestations of numerous interacting genomic imbalances, mutations and environmental factors [33]. Genetic variants resulting from Copy Number Variants (CNVs) and Single Nucleotide Polymorphisms (SNPs) act additively and are present in approximately 10% of individuals with ASD [30,31]. However, there is no single identified mutation that accounts for over 1% of ASD cases, leaving the fundamental genetic factors underlying the spectrum of autism phenotypes incompletely defined [31].

Structural variations in chromosomes are implicated in ASD, with linkage on chromosomes 5, X, and 19, and minor evidence for linkage on chromosomes 2, 3, 4, 8, 10, 11, 12, 15, 16, 18, and 20 [33,34]. ASD is 4-8 times more common in males than females, emphasizing the

**Table 2:** Summary of strategies for improving the dental environment for patients with autism [49,50,52].

| Decrease  | Utilize  |
|---|--|
| <ul style="list-style-type: none"> <li>• Bright lights</li> <li>• Loud noises</li> <li>• Multitude of people present</li> <li>• Light touch</li> <li>• Strong odors &amp; flavors</li> <li>• Prolonged wait time</li> <li>• Food/sweets as reinforcers</li> </ul> | <ul style="list-style-type: none"> <li>• Dimmed lighting</li> <li>• Rhythmic music</li> <li>• Deep pressure</li> <li>• Favorite music or video</li> <li>• Private/quiet room</li> <li>• Weighted blankets/swaddle blanket + pillows</li> <li>• Advance preparation</li> <li>• Caregiver input &amp; interview</li> </ul> |

significance of X-linked inheritance [30]. Polymorphisms in the X chromosome are observed to result in intellectual disability due to the location of various genes that express neuronal function on the X chromosome [31]. Impairments in language and social cognition are observed with several of these mutations [32].

### Gastrointestinal Considerations for Individuals with Autism Spectrum Disorder

Gastrointestinal symptoms and disorders are among the most commonly reported medical conditions associated with autism spectrum disorder. However, gastrointestinal disorders can be challenging to recognize due to communication barriers that exist for many patients diagnosed with ASD. Symptoms that traditionally present include constipation, Gastroesophageal Reflux Disease (GERD), diarrhea, and vomiting. Kang et al. [35] evaluated gastrointestinal dysfunction in a cohort of 164 children with ASD. Forty nine percent of the children with ASD exhibited chronic gastrointestinal complaints, including diarrhea, constipation, bloating, gassiness, vomiting, and GERD [35]. These commonly experienced gastrointestinal symptoms often cause pain and discomfort, and may be linked to unusual eating and sleeping habits, anxiety, and regression of ASD symptoms [36].

### Potential Microbial Causes of Gastrointestinal (GI) Symptoms

The gut and brain have signaling pathways, which affect exchange of metabolites, influence the immune system, and control gene function in an individual [37]. “Cross talk” between the gut and brain may occur through a direct connection, in which the lamina propria of GI endothelial cells is triggered to release signaling molecules into the GI tract, or through an indirect link, by changing motility, secretion, and permeability in the intestine. This gut-brain communication is influenced by the individual’s unique enteric microbiome [37]. Children with ASD often have an altered gut microbiota [38,39]. Strati et al. [38] described a decrease in the abundance of the genus *Alistipes*, *Bilophila*, *Dialister*, *Parabacteroides*, and *Veillonella* in individuals with ASD. However, some microorganisms including *Collinsella*, *Corynebacterium*, *Dorea*, and *Lactobacillus* were significantly increased compared to individuals without ASD. This study identified an association between constipation and different bacterial patterns of the gut, and concluded that the constipation experienced by many individuals with ASD could be attributed to these microbial differences.

### Microbiota Transfer as Promising Treatment for Autism Spectrum Disorders

Microbiota transplant has been proposed to be a promising therapy for individuals with ASD. Current data suggests that shifting the gut microbiota to a healthy state can reduce the gastrointestinal

symptoms associated with ASD. Because these symptoms not only cause pain and discomfort, but include behavioral symptoms as well, altering the microbiota in individuals with ASD may potentially affect eating and sleeping habits, anxiety, and symptom regression [36, 40]. Efforts to change gut microbiota include the addition of probiotics and/or prebiotics to the diet, or fecal matter transplants. Shigwedha et al. [41] suggested that adequate intake of probiotics or probiotic cell fragments plus commensal microbiota could facilitate the smooth exchange of metabolites with the host, influence the host metabolism and immune system, and affect host gene function. Using fecal microbiota transplant (FMT), Kang et al. [39] repopulated the standardized gut bacteria within a clinical cohort of children with ASD. After FMT, the microbial profile shifted towards that of age-matched healthy control subjects. The shift in microbial populations, as well as improvements in behavioral and gastrointestinal symptoms, lasted for an 8-week period post-treatment.

## Oral Health Status and Dental Caries Risk for Individuals with Autism Spectrum Disorder

Recent meta-analysis assessed the oral health status of children with ASD compared to typically-developing individuals. The systematic review concluded that considerably higher prevalence of dental caries and periodontal diseases occurs in patients with ASD [42]. However, other studies have reported no differences in caries prevalence between children exhibiting autistic or typical behavioral tendencies [43]. Regardless, children with autism are noted to have poorer oral hygiene, modified dietary behaviors, and lower compliance in oral health maintenance [42,43].

While all people with teeth are susceptible to caries development, higher risk exists for patients with autism due to specific behaviors. Adolescents with autism may display eating habits of pouching a food bolus between molars and the cheek as a result of lack of tongue coordination. The location of food pouching is often along the posterior segments of the jaws, affecting risk for caries development in these areas [44]. Caries risk is also affected by difficulty in brushing and flossing to maintain oral hygiene, as children with ASD experience increased sensitivities and oral aversions [45]. Children with ASD often exhibit strong preferences for starchy and processed food over fruits and vegetables [46,47]. Another manifestation in some individuals with ASD is pica eating disorder, the tendency to mouth or swallow inedible or non-nutritive substances that are not characterized as food [48]. This behavior may lead to multiple dental complications, such as abrasion, tooth fracture, staining, periodontal problems, and poor oral hygiene.

## Autism and Dentistry Practices

Sensitivities and sensory processing alterations can cause significant challenges in the dental environment, prompting a “fight or flight” response to overwhelming stimuli [49]. Approximately 50% of children with ASD have been reported to possess oral aversion or defensiveness. The dental clinic itself has many anxiety-producing stimuli including bright lights, loud noises, and materials of unfamiliar textures, smells, and tastes. Multiple operatory units in the same room can cause confusion and increased disturbance due to noise and presence of people coming and going [50].

Stein et al. [51] found that significantly more parents of children with ASD, compared to parents of typical children, reported that their child was afraid of, disliked, or complained about: dental drilling, bright lights, loud sounds, having someone put instruments in his or

her mouth, leaning back in the dental chair, and smells of the dental office. Parents of children with ASD reported significantly more difficulty with three or more of these sensory variables compared to of parents of typical children. Furthermore, parents of children with ASD were more likely to report the use of restraint for routine cleaning of teeth, as well as general anesthesia, sedation, or other drugs for dental prophylaxis [51].

Sensory aversions may result in a dislike for the foaming or flavor of toothpaste and the feeling of the toothbrush, complicating attempts at plaque removal. Alternatives such as toothbrushes of different texture or design, electric toothbrushes, or a washcloth may improve patient acceptance to hygiene aids [50]. Patients may find a compatible dentifrice by trying different flavors and brands of toothpaste, or consider brushing the teeth with fluoridated mouthwash, as this produces less foaming and may be milder in flavor.

## Access to Care

Finding a dental home may also be more difficult for individuals with autism. Dentists accessible to the child may not be qualified or appropriately trained to manage patients with autism or associated comorbidities. Significant behavioral tendencies among patients with autism may also be a factor in locating a dentist equipped to welcome patients with special healthcare needs. In order to find a dental home, many families of children with autism may be forced to travel long distances or seek care in a dental educational institution [49,50]. Stein et al. [51] reported higher incidence of parents having difficulty locating a dentist to provide care to their child with ASD, or having been refused treatment by a dentist. Parents cited most frequent reasons for refusal of services as inadequate training of the dentist for Special Healthcare Needs (SHCN) patients and the child’s behavior problems.

## Behavioral Approaches

Patients with ASD often present with challenging behaviors including non-compliance to directions, hyperactivity, sensory hypersensitivity, combativeness, and self-injurious behavior. Behaviors may be the outcome of a patient’s anxiety, and range from emotional outbursts to destruction of objects to harming of others [52].

Non-pharmacologic methods of behavior guidance use positive interactions and cultivating relationships between the patient and the dental team, which may be difficult for children with ASD who exhibit impaired social communication. Traditional non-pharmacologic behavior guidance techniques include “positive reinforcement, Tell-Show-Do (TSD), distraction methods, non-verbal communication, and voice control”. Patients with ASD who have expressive and receptive language deficits may not be as amenable to these types of guidance [49].

Visual pedagogy may be more effective for children with autism who respond well to pictures than to words. Books, color photographs, stories, and video modeling can be helpful adjuncts to more traditional guidance techniques. Visual tools such as a visual task strip or story-board depicting a sequence of events (Table 1) and social stories about dental visits, as well as other life skills, are available on the Internet from variety of sources [49,52-54].

In-depth knowledge and understanding of basic behavior patterns is important to successfully manage children with ASD in the dental setting. Most significantly, dental providers must

remember that patients with autism exhibit a broad variety of ability, performance, and intelligence levels. A tailored approach unique to the characteristics of each child is of utmost importance [50].

The Centers for Disease Control (CDC) and National Research Council (NRC) recognize the importance of early diagnosis and treatment for patients with ASD, and support education focusing on the development of motor skills, social and language skills, and behaviors considered appropriate. Educational intervention therapy is indicated as soon as ASD is suspected, and should be provided a minimum of 25 hours per week [49]. Education for individuals with ASD includes combinations of Applied Behavior Analysis (ABA), structured teaching, speech and language therapy, learning of social skills, occupational therapy, and sensory integration therapy. ABA is well supported as an efficacious intervention for patients with ASD, and ABA-based therapies are generally recognized as some of the most effective in improving behaviors and life skills. These therapies strive to reinforce desired behaviors and modify undesirable behaviors and/or responses, recognizing the child's behavior as it relates to his or her environment. ABA methods are often used in educational programs to provide life skills to patients with ASD, and can be modified to the dental setting as well [49].

### Systematic Desensitization

Systematic Desensitization is a technique that can successfully modify anxiety behavior in the dental setting. Gradual exposure over time to anxiety-producing components of the dental environment allows patients to receive dental care more comfortably. A child is slowly and repeatedly exposed to the dental environment with the objective of gaining trust and enhancing adaptation [49]. Cooperation is encouraged with the use of positive reinforcement and practicing desired behaviors both in the dental office and in an external mock environment. Use of a positive reinforcer (such as a sticker or small prize) in combination with praise to encourage desired behaviors can result in the child's cooperation for dental examinations and prophylaxis [52]. Utilizing systematic desensitization in the dental office may require visits as long as 2 hours, with 10-12 visits to achieve the desired result. Desensitization has a high success rate, but the extrapolation of results may be limited when the desensitization process has taken place in a specific environment and with a specific provider. The time required for this behavior training is often prohibitive in the dental community [49]. Practicing in a mock environment such as the home or with the child's therapist may facilitate the use of desensitization to achieve improved behaviors in the dental office [52].

Orellana and colleagues [55] have described applications of the TEACCH model (Treatment and Education of Autistic and related Communication-Handicapped Children) to the dental environment. TEACCH is "a professional training program and a clinical service for persons with ASD and their families throughout the whole lifespan". Structured teaching is based on the neuropsychological profile of people with ASD, and is reliant on the temporal and spatial organization of visual information [56]. Orellana's group applied the TEACCH model to two groups, child and adult, with the goal of improving acceptance of dental care in the conventional clinic setting.

Techniques used were:

- Successive Approaches of desired behaviors.
- Tell-Show-Feel-Do, a modification of the common

Tell-show-do behavioral guidance technique to include feeling of sensations or instruments prior to clinical use.

- Visual pedagogy, wherein photographs, pictographs, and real objects are associated with short simple sentences. A set of 20 photographic cards (depicting the room, instruments, light, etc.) was used for each subject describing a dental exam experience.
- *In Vivo* modeling, wherein a live person demonstrated desired behaviors.
- Audio-Visual modeling, showing a film of an *in vivo* model.
- Behavioral trials sequentially practicing ten steps of a mouth examination.
- Auto-Modeling, wherein photos of the subjects were taken during the course of the appointment and then reviewed later emphasizing the positive behaviors. Subjects were encouraged to practice these actions.

Orellana's group reported an improvement in Frankl behavior scores and increase in receptiveness to dental care and the dental environment after five 20-minute sessions occurring over a period of 3 weeks. After the 5 sessions, over 90% tolerated intraoral examination with both mirror and probe. By the end of the five sessions, 81.6% of children and 100% of adults had a Frankl score of 3 or 4. The authors noted that the amount of behavioral improvement was unrelated to the level of cognitive impairment of the subject [55]. This study demonstrated remarkable improvements in subject compliance, and offers examples of how applied behavior analysis may be targeted for the dental office.

### Advanced behavior guidance techniques

Impairments in social skills may decrease the effectiveness of desensitization and ABA-based therapies, or require longer periods of time to see positive results. For patients with extreme aversions and impaired social skills, or for patients with active dental disease at risk of pain and infection, the modalities of General Anesthesia (GA) or Protective Stabilization (PS) may be required initially to reduce risks of morbidity in an urgent situation [49]. PS may be required when an urgent diagnosis or treatment is required, or for patient and staff safety when uncontrolled movements occur. In some cases, PS may be calming to a child with autism due to the pressure produced with application, however care must be taken to prevent injury for patients who have unanticipated reactions to the stabilization. When utilizing PS, adherence to standard guidelines must be observed [57].

Use of sedation may be helpful in some cases; however practitioners must rule out comorbidities and medication use that contraindicate procedural sedation and observe established guidelines for case selection and monitoring [58,59]. Nitrous Oxide (N<sub>2</sub>O) used as a behavior guidance tool has mixed support in the literature. N<sub>2</sub>O anxiolysis may be helpful for patients with mild behavior concerns, and is possibly more effective when combined with other behavior guidance techniques [59]. Some parents or caregivers may object to the use of N<sub>2</sub>O due to concerns about potential Methylene Tetrahydrofolate Reductase (MTHFR) gene mutations. MTHFR related gene mutations and folate metabolism dysregulation have been reported in patients with autism. However, there is no evidence of mortality associated with use of nitrous oxide as typically administered in the dental setting [52]. Deaths associated with MTHFR deficiency have only been reported in cases with prolonged exposure to high levels of nitrous oxide under general

anesthesia, and risk is higher for patients that are homozygous for the genetic mutation [60,61]. Providers should help parents make informed decisions about the use of N<sub>2</sub>O by discussing risks and benefits and other possible treatment options and by consulting with practitioners regarding folate metabolism anomalies and MTHFR genetic mutations [52].

General Anesthesia (GA) is a frequent modality for patients with autism, due to factors such as extensive treatment needs, patient safety, dental provider and team safety, and uncooperative behavior [52]. Approximately 40% of patients with autism require GA to safely administer dental intervention [50]. Although GA is generally considered to be safe, patients with autism have been reported to experience adverse events including significant disruptive behaviors, postoperative vomiting, postoperative seizures, and patient manipulation of surgical sites causing bleeding. Challenging perioperative behaviors may necessitate the need for pre-medication as well as additional staff or stabilization [52].

## Dental Appointment Considerations

Parents may have their own preferences about restorative materials, fluoride-containing products, behavior management strategies, personnel, or location inside the office for dental examination. A family centered approach is crucial in building trust with patients and parents. Collaborative planning of the patient's care can result in more effective long-term oral health maintenance [52].

Some caregivers or parents may object to dental products containing fluoride or restorative materials containing mercury (amalgam) or bisphenol-A (resin composites) due to concerns about toxicity. The reasons for refusal of these products should be carefully discussed with the parents, along with caries risk assessment and exploration of alternatives. Discussing options with caregivers in a detailed and family centered manner will aid in making treatment-planning decisions [52]. Alternatives to fluoride could include chlorhexidine or xylitol as topical chemotherapeutic agents. Alternatives to amalgam and composite could include glass ionomer products and stainless steel crowns.

Patients with ASD can often tolerate procedures better when the events are predictable and expected. Helping families to prepare ahead of time will make dental appointments go more smoothly. Caregivers are valuable partners in this endeavor, as they know the child's behavior and communication styles well and can provide information about what approaches have worked well for the patient in other environments. A pre-visit questionnaire for caregivers, such as the one published by Nelson et al. [49], includes information about the child's behaviors, sensory sensitivities, recommended time of day for procedures, time required, and other alterations in the environment to improve patient comfort. Sensory-Adapted Dental Environments (SADE) reduces the presence of potentially distressing stimuli, for example by removing fluorescent lighting and by playing relaxing rhythmic music. Dark glasses and noise-canceling headphones or ear-muffs may also help to avoid overstimulation in the dental office [49,50].

Communication from the dental team in a calm voice using short, simple sentences may help reduce patient anxiety as well as clarify expectations. Avoid symbolic language or figures of speech, as patients with ASD are likely to interpret language literally. When touching a patient, use firm pressure rather than light touch, and avoid unnecessary contact. Use of massage by the caregiver or dental

provider and coping objects (such as a toy or tablet/computer) may improve patient response. Some patients with ASD are soothed by pressure, and may benefit from use of a weighted blanket (such as the x-ray apron) or swaddling with blankets/pillows [49] (Table 2).

## Conclusion

Autism Spectrum Disorders encompass a wide range of symptoms, presentations, abilities, and challenges. The genetic, neurologic, sensory, and gastrointestinal considerations associated with ASD affect daily life, oral health, and the ability to receive dental care. The psychological well-being of parents and caregivers are often influenced by the behavior of their children. Nearly two-thirds of parents with a child with ASD report difficulty with daily oral care and significantly more need for physical assistance in performing daily tasks. Raising a child with ASD necessitates adaptation to the child's routines and can pose challenges for engagement in the educational and health care systems. Furthermore, limited availability of resources to support families with a child with ASD can complicate access to care. Thus, a dental visit can represent a major source of stress for all individuals, including the child, caregiver, and provider. Dental healthcare professionals with a thorough understanding of autism spectrum disorder and associated conditions will be better prepared to provide a welcoming environment for patients with autism and their caregivers. Patience, collaboration, and an individualized approach are crucial in providing oral health care in an effective, safe, and positive environment for this growing sector of the population.

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