General Dentistry for Children with Cerebral Palsy

Harvey Levy

Contents

H. Levy (✉)
Department of Surgery, Frederick Memorial Hospital, Frederick, MD, USA

University of Maryland School of Dentistry, Baltimore, MD, USA
e-mail: pubs@drhlevyassoc.com

F. Miller et al. (eds.), *Cerebral Palsy*,
https://doi.org/10.1007/978-3-319-50592-3_81-1

Abstract

Dental treatment is considered the greatest unmet health need of the disabled (Kumar et al., J Indian Soc Pedod Prev Dent 27(3): 151–157, 2009). Ever since its initial description by Dr. WJ Little in 1861 (initially known as Little's Disease) and later called cerebral palsy (CP), it has prevented children from receiving the same level of oral health care as other children, despite the fact that it is currently the most common congenital neuromuscular disorder (Jones et al., J Pediatr Health Care 21(3): 146–152, 2007; Patton and Glick (eds), The ADA practical guide to patients with medical conditions. Wiley-Blackwell, Hoboken, 2012).

There are many reasons that children suffering from CP do not enjoy the same quality of life, including freedom from oral discomfort, pain, and infection. The complexities of raising a child with CP mean that oral health often takes a back seat to the child's other needs. Dental professionals may be uncomfortable, untrained, unable, or unwilling to treat these children. This chapter will address daily proper home care as well as adequate and correct dental diagnoses, treatment plans, and successful procedures in dental care settings. It will also outline unique procedures utilizing acupressure points to safely open and maintain open the mouths of children with CP so that dental professionals can perform adequate clinical exams and treatment. Clinical cases will be presented to clarify or illustrate some of these points.

Keywords

Cerebral palsy · General dentistry · Pedodontics · Acupuncture · Mouth opening

Introduction

For children with CP, access to care remains a challenge. With greater knowledge and proper training, caretakers of the affected child can more effectively meet this challenge.

CP is a group of neuromuscular disorders that affect the development of movement and posture and cause limitation in activity, affecting 2–2.5/1000 live births (Sehrawat et al. 2014), with other authors reporting a wider worldwide range of 1.5–4/1000 live births (Alhashmi et al. 2017). Classification includes spastic, dyskinetic/athetoid, ataxic, or a combination of two of these. Spastic CP, accounting for 50–75% of the cases, includes awkward, jerky movements, muscle tightness, and joint stiffness. Dyskinetic (aka athetoid, dystonic), accounting for 15% of the cases (Escanilla-Casal et al. 2014), is characterized by ceaseless involuntary, writhing movements. Ataxic, the remaining 5–10%, shows a lack of muscle coordination, affecting speech, gait, swallowing, muscle control of the eyes, and voluntary movements of the hands.

Dental practices may be ill-equipped to handle the physical and emotional needs of children suffering from CP. To assure greater access to care for children with CP, this chapter will address both common as well as unique clinical issues. These include the ability to perform routine daily oral hygiene at home, as well as the same quality effective dental care afforded to all children in a dental office or off-site facility.

Reasonable modifications may include desensitization, behavior modification, chemical and physical restraint, forced mouth opening using manual pressure on various acupuncture points, maintenance of mouth opening with various oral props, and modalities of treatment including oral sedation, injectables, or general anesthesia. Modifications to standard oral health care will be part of this discussion, including use of mechanical

plus chemotherapeutic agents, with a heightened dental awareness on the part of the family, caregivers, and dental professionals.

Common Issues

Common issues in children with CP include poor oral hygiene, bruxism, drooling, traumatic dental injuries, and malocclusion. Dougherty (2009) described changes in the orofacial structure in patients with CP that may prompt parafunctional habits, which in turn can cause feeding problems, difficulty maintaining oral hygiene, and barriers to oral care access.

The increased risk of dental problems can result in significant morbidity that can affect well-being and can negatively affect quality of life. The neurological insult, including motor and coordination difficulties and limited oral hygiene, results in increased risk of dental disease (Jan and Jan 2016).

Dental problems observed in many of these children include gingival hypertrophy, enamel hypoplasia, dental trauma, bruxism, drooling, and class II malocclusion. Risk factors for dental disease in these children include exposure to multiple medications, reduced oral hygiene, soft or cariogenic diets, periodontal disease, or feeding via gastrostomy tube (Escanilla-Casal et al. 2014). Poor oral hygiene and periodontal disease are influenced by medical diagnosis, IQ level, having a disabled sibling, parents' level of education, and economic status.

Similarities and Differences to Other Mental and Physical Challenges

Only 25% of all children with CP have seen a dentist, compared with 40% for all other children (Stoopler 2014).

Cerebral palsy itself may not directly cause dental problems. But the sum of all the associated phenomena predisposes children with CP to issues that adversely affect their quality of life. Jan and Jan (2016) have correlated the following predisposing factors to known mechanisms:

- Motor weakness and cognitive delay ➔ reduced oral hygiene, dependence on caregiver and dental team
- Pseudo-bulbar palsy ➔ drooling, chewing, and swallowing problems
- GERD ➔ vomiting, enamel erosion, regurgitation, possible aspiration
- Malnutrition ➔ poor calcium intake, vitamin D deficiency

Pope and Curzon (1991) found a similar number of dental caries, but children with CP had more extractions and unrestored teeth, fewer and poorer-quality restorations, worse oral hygiene and gingival health, delayed eruption, and higher levels of tooth wear. One study by Nielsen (1990) found that the caries rate for children with CP was lower than that of the control group.

Das et al. (2010) found no difference in the process of periodontal disease, prevention, or treatment in children with CP vs. other children. The difference was the inadequate plaque removal. Effective oral hygiene has two requirements: motivation and manual dexterity. The motor coordination and muscular limitations of children with CP along with difficulty in understanding the importance of oral hygiene led to the progression of periodontal disease. Poor oral hygiene led to both increased caries and periodontal disease, which affects the nutritional status of the child. The bleeding, swelling, and pain of periodontal disease can make eating more difficult and sometimes painful or untasty. Loose teeth caused by bone loss from periodontal disease can trigger pain when teeth contact non-compressible objects or even hard foods.

Risk Factors

In this chapter, we will discuss the ways in which CP places children at higher risk of dental problems and affects their medical-dental quality of life. The most significant risk factor is aspiration (see "Case #5 Maria"). Aspiration occurs when saliva, fluid, or food goes into the trachea. This can happen in the dental office where the patient, supine in a dental chair, is an easy target for water, dental materials, debris, or an extracted tooth entering the lungs. In the office, a throat shield should be used when a rubber dam is not in place. Suction (high velocity evacuation system) must be aggressive and thorough to prevent life-threatening aspiration (Sehrawat et al. 2014). A patient's airway must be maintained at all times to prevent a potentially fatal incident.

dos Santos et al. (2002) reported that children with CP had higher frequency of decayed, missing, and filled teeth (DMFT), higher plaque score, more strep mutans, higher lactobacillus counts, and lower pH and buffering capacity in the saliva, increasing the risk for dental caries. The risk factors for malocclusion and trauma will be discussed later.

Quality of Life

Several researchers (Abanto et al. 2012; Cardoso et al. 2014) have demonstrated that the more severe the neurological damage in children with CP, the higher the risk of oral disease, because of the soft consistency of the diet and the difficulty obtaining effective daily oral hygiene and professional oral care. The severity of dental caries is strongly associated with a negative quality of life.

Additionally, anticonvulsant drugs in the presence of poor oral hygiene result in gingival hyperplasia. Athetoid movement, motor impairment, or the absence of information about dental care, or a combination, precludes effective oral hygiene. The harmful biofilm builds up, causing dental problems and decreasing the quality of life.

It appears universally accepted that the best quality of life for these patients occurs when there is an integrated approach. This includes dentistry, physical therapy, speech therapy, and caregivers working in harmony (Katz 2012).

The burden of a reduced quality of life can also affect the caregivers whose children have a high decayed-missing-filled-teeth (DMFT) count, manifesting as strain, isolation, disappointment, and environmental concerns (Rodrigues dos Santos et al. 2009; Santos et al. 2010a).

In evaluating preschool children, Du et al. (2010) determined that those with CP had lower Health and also lower Oral Health Pediatric Quality of Life inventory scores than the control group in all four categories of physical, emotional, social, and school functioning.

Dental Awareness and Oral Hygiene Education for Parents and Caregivers

Dieguez-Perez et al. (2016) are some of many authors who urge early dental treatment and frequent home care to overcome what he observed as poor oral hygiene in children with CP. Relative to other children, he observed a higher caries incidence, worse gingival health, more dental trauma, more parafunctional habits such as bruxism, more delayed eruption, more wear, and more abrasion. Families and caregivers need to be made aware early on that oral manifestations of CP include malocclusion, bruxism, sialorrhea (hypersalivation and drooling), and extensive calculus from dysphagia, pooling saliva, and possible gastrostomy tube feeding (Patton and Glick 2012). Tell-show-do is essential, as is talking to the patient directly, if they are capable of understanding. Oral hygiene instruction and treatment plans begin with the ideal and then are modified as appropriate for the child's age, abilities, and level

of comprehension and compliance (Patton and Glick 2012).

We never assume that the parents or caregivers know the basics of oral hygiene. As dental professionals, we make sure that they are aware of proper oral hygiene with necessary modifications so they can supervise or monitor the child. They may not be aware of using an electric toothbrush, floss handle, water pick, or special mouth rinses.

Given the greater likelihood of traumatic dental injuries, including avulsion of upper front teeth from falls or accidents, a tooth-saving kit should be available in all homes or group homes. That would increase the chances of the dentist being able to reimplant an avulsed tooth in a timely manner.

Clinical Concerns

Lip Biting

Lip biting is well known in children after local anesthesia and is clearly documented in children with disorders like Lesch-Nyhan syndrome. For children with severe class 2 malocclusion and a clear overjet, the lower lip is often found tucked between the lower incisors and the protruded upper incisors. The lower lip then becomes red, raw, and irritated. Drooling and incompetent lip seal are often associated with this lower lip pathology, as are nutritional intake concerns. Dentists, especially orthodontists, may mitigate the problem by fabricating hard acrylic or resin lip guards or occlusal mouth guards, similar to those used to reduce bruxism's harmful effects on the enamel. Biting one's lip, tongue, or cheek following local anesthesia is also a preventable problem, with details in a later section.

Bruxism, Clenching, and Grinding

About 20% of all children appear to have some form of clenching, grinding, or bruxism (Fig. 1). Researchers cannot agree on what percentages of children with CP have this issue, but the consensus is that it is significantly higher than for the general population, anywhere from 25% to 69.4% (Alhashmi et al. 2017; Peres et al. 2007). Along with a higher DMFT count, there is an increase in malocclusion and parafunctional habits including bruxism. Other than removable acrylic mouth guards, one treatment option for this would be a fixed and secured resin protective appliance (Oliveira et al. 2011).

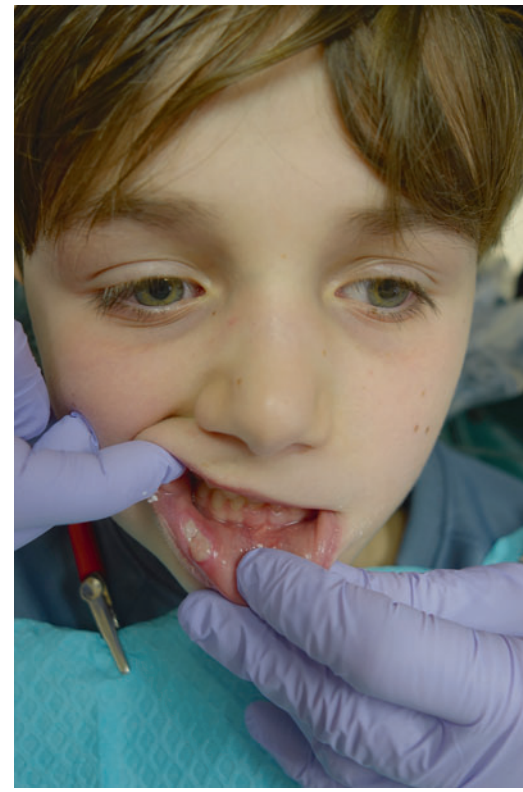

Fig. 1 Lower lip bite following local anesthesia

Botti Rodrigues Santos et al. (2015) observed that for children with spastic CP, teeth grinding is associated with worsened oral motor performance. A gnathodynamometer was utilized to check maximum bite force and confirmed this observation.

Souza et al. (2015) found bruxism in 36.3% of their children with CP and contend that dental caries and bruxism have a negative effect on quality of life (Fig. 2).

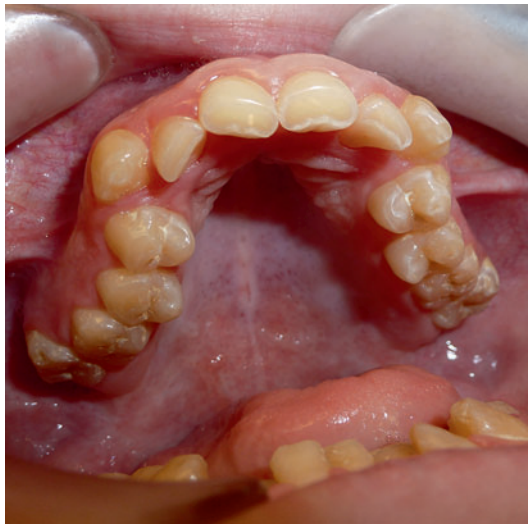

Fig. 2 Moderate bruxism

Miamoto et al. (2011a) found that the 25% sleep bruxism rate was not statistically different from those of the control groups and maintained that a multidisciplinary approach yields the best success for improvement. They used biofeedback, EMG, drugs, myorelaxation plates, and night guards to reduce the parafunctional sleep bruxism's tooth wear, which compromises the dentition.

In evaluating children with spastic CP, Santos et al. (2010b) noted the oral motor function correlated with the EMG activity in all muscles tested. The patients with CP had motor weakness in jaw-closing muscles, which may compromise masticatory function (Fig. 3).

In addition to bruxism, other parafunctional habits found more frequently in children with CP include pacifier sucking, finger sucking, biting objects, and tongue interposition. Intervention is recommended only if the situation is unlikely to self-correct with age (Ortega et al. 2007).

Drooling

Drooling is noted in 30% of children with CP but is not associated with increased saliva flow. It is secondary to mouth opening or swallowing difficulties, or both, which can lead to aspiration, skin irritation, articulation difficulties, and social embarrassment. One of the treatments used to control drooling is botulinum toxin injected into the parotid and submandibular glands (Alhashmi et al. 2017).

Fig. 3 Severe bruxism

Lip position and oral seal are strongly associated with drooling (Tahmassebi and Luther 2004). Hegde and Pani (2009) noticed that 48.7% of the children with CP drooled, with 17.7% being severe. The more drooling, the poorer the oral hygiene score. Those with athetoid CP drooled the least. Zamzam and Luther (2001) verified by both remote surveillance and direct exams that poor or incompetent lip position correlates with drooling in children with CP.

Harris and Dignam (1980) reported a 73% reduction in drooling with chin cups and special anti-drooling practical courses. Johnson et al. (2004) used an Innsbruck sensorimotor activator and regulator (ISMAR) intraoral appliance to reduce drooling and improve eating skills in children with CP.

Maeda et al. (1990) reported that surgical submandibular duct relocation resulted in less drooling, less odor, less time in oral care, and improved appearance.

Inga et al. (2001) use colored bandanas to mask the drool onto the child's clothing. In the 1990s, Castillo-Morales (Inga et al. 2001) developed removable palatal plate appliances with a button on the palate used to facilitate swallowing and reduce drooling. The appliance resembles a Hawley retainer, which is familiar to most dentists. This can be fixed for non-compliant patients and is most successful if the patient can swallow on command rather than drool.

Fig. 4 Incompetent lower lip

Incompetent Lip Seal

Infants who cannot create a good lip seal may not be able to breastfeed. Infants with CP who do not breastfeed have 3.4 times more throat infections than those who do. Miamoto et al. (2011b) noted that 18% of children with CP had poor lip seal compared with 5% for the control group, which was quite relevant in protecting the upper front teeth from dental trauma (Carneiro et al. 2017). Hypotonia contributes to drooling, as does an open bite and inability to close lips (National Institute of Dental and Craniofacial Research [NIDCR] 2014) (Fig. 4).

Dental Trauma

The class II malocclusion generally features flaring of the maxillary incisors. These upper front teeth are prone to fracture when accompanied by incompetent lips or struggles in ambulation and seizures (Alhashmi et al. 2017). The most common risk factors associated with this malocclusion are mouth breathing, lip incompetence, and long face. The uncontrolled head movements cause the upper front teeth to strike hard objects. The absence of a good lip seal, which normally protects the upper incisors, plus recurrent seizures and night grinding, makes the child prone to dental injuries. Other observers (Holan et al. 2005) noted that children with CP had a much higher incidence of dental injuries even though they do not engage in violent sports activities. Teachers, parents, and caregivers should be made aware of emergency care in dealing with traumatically avulsed permanent teeth (Dubey et al. 2015).

Fig. 5 Fracture trauma to upper front teeth

Part of the high percentage of trauma to the front teeth of children with CP is due to the physical and mental impairments that reduce defensive reflexes (Miamoto et al. 2011b) (Fig. 5).

One study found that children with CP have similar numbers of traumatic dental injuries but receive less treatment (dos Santos and Souza 2009).

Caries

While not universally observed, Cardoso et al. (2014) and most authors documented a greater prevalence of dental caries in primary dentition of children with CP than in nondisabled children (Ortega et al. 2007). Sinha et al. (2015) correlated a higher incidence of dental caries with poor oral hygiene, class II malocclusion, compromised general health, and low dental awareness. Observing that diseases of the mouth occur with greater frequency in children with CP than in control groups, Roberto et al. (2012) state that dental caries constitutes a multifactorial disease in which different biological, cultural, and environmental factors interact.

Other factors contributing to the reportedly higher incidence of dental caries in this group of children include mouth breathing, effects of medication, enamel hypoplasia, and food pouching (NIDCR 2014). Many medicines reduce salivation or contain sugar or both. Caregivers should be encouraged to find sugar-free medicines and rinse with water after taking them. Alternatives to soft, cariogenic food and beverages are advised. Pouched food should be removed with a finger or gauze after every food intake (Fig. 6).

Fig. 6 Caries plus trauma

These children need to have a specific, personalized protocol and means of brushing their teeth twice daily, flossing once daily, nightly fluoride, and sealants on all posterior teeth at risk of dental caries.

In treating caries, silver diamine fluoride has emerged as a practical, inexpensive restorative material. Its fluoride release coupled with its low cost and ease of application significantly offsets the fact that it is not as esthetic as polished composites. These are excellent for decayed primary teeth that will exfoliate within a few years, especially where cost, ease of application, and durability are more important than short-term cosmetic beauty.

Periodontal Disease (Gingivitis, Periodontitis)

Gingival health is often poor, primarily because of difficulties in maintaining proper oral hygiene. Predisposing factors include poor neuromuscular control, food pouching, and mouth breathing. Gingival hyperplasia is often related to the use of anticonvulsant drugs, calcium channel blockers, or immunosuppressive drugs (Alhashmi et al. 2017).

Jaccarino (2009) reports that periodontal disease is three times higher in patients with CP than in the control population, noting that poor oral hygiene, soft cariogenic diet, and anticonvulsant Dilantin are contributing factors.

In our office, all patients with special needs, including children with CP, are seen by the hygienist every 3–4 months. This visit focuses on evaluating and cleaning the teeth and gums, following up on prior findings, and catching any new or incipient pathology. Parents and caregivers are given feedback on the child's level of gingival and periodontal health and instructed on strategies to improve the clinical picture. Radiographic and photographic images are taken and then displayed on our TV monitors for clarity and discussion. Six

Fig. 7 Periodontal disease with moderate calculus

Fig. 8 Periodontal disease with heavy calculus bridge

sites on different teeth are measured for periodontal pocketing. If any are greater than 3 mm, then the entire mouth is probed to rule out periodontal disease. Unless the child is too uncooperative, cleaning is done at this time. If it is unsafe to proceed, the patient is rescheduled with orders for a higher level of sedation, reminder to arrive on an empty stomach and empty bladder (or diaper/Pull-Up), and the proposed clinical procedures agreed upon. The subsequent visit may be in the dental office, facility, or operating room. Signatures are obtained for the informed treatment plan, physical restraint, and chemical restraint (Figs. 7, 8).

GERD, Erosion, and Wear

Children with CP have a higher risk of dental erosion, especially all molars and the upper incisors (Gonçalves et al. 2008). Reports of GERD

Fig. 9 GERD in 5-year-old child

(gastroesophageal reflux disease) range from 43% to 70%, with the involuntary passage of gastric juice passing against the normal flow of the digestive tract. This rumination causes erosion of teeth (Alhashmi et al. 2017). Su et al. (2003) reported as many as 75% of children with CP having GERD, which in turn led to dental erosion. Shaw et al. (1998) contend that GERD correlates with erosion more so than parafunctional habits (Fig. 9).

The dentist may consult with the physician to discuss medical management of the reflux. In the dental office, patients should be seated upright for treatment. Caregivers should be advised to rinse the child's mouth with plain water or a water and baking soda mixture at least four times per day to mitigate the harmful effects of the gastric acid. It is essential that the child's teeth are brushed twice per day and that he or she receive a daily fluoride treatment.

Malocclusion

Malocclusion in children with CP is usually a musculoskeletal problem rather than simply misaligned teeth. An anterior open bite with protruding upper front teeth is common and often associated with tongue thrusting (Fig. 10).

Class II malocclusion was the most common type of malocclusion at 64.2%, along with increased horizontal overjet, vertical overbite, missing teeth, anterior diastema, and incompetent lips (Dubey et al. 2015). Most children with CP are poor candidates for orthodontic correction of the malocclusion. A high level of behavior compliance both with daily home care and at the

Fig. 10 Malocclusion with crowding, anterior open bite, and drooling

Fig. 11 Anterior open bite with incompetent, inflamed lower lip

dentist/orthodontist's office is required, along with maintenance of excellent oral hygiene. Removable appliances may be dangerous, and fixed appliances are expensive. More often than not, the offending or problematic teeth are removed and not replaced. This, in turn, leads to greater speech impediment, reduced nutritional efficiency, migration of teeth, and social embarrassment (Alhashmi et al. 2017) (Fig. 11).

Temporomandibular Joint (TMJ) Dysfunction

The frequent class II malocclusion is associated with a higher incidence of TMJ problems, including tenderness upon palpation, pain on opening or chewing, crepitus, limited mandibular movement, or luxation of the condyle. TMJ problems are more often found in children with CP who are male, mouth breathers, or have severe malocclusion (Alhashmi et al. 2017). One author cites the frequency of TMJ signs/symptoms as 67.6% for children with CP compared with 25% for the control group (Ortega et al. 2008).

Dental Treatment for Children with CP

Many general dentists refer children with CP to the pedodontist (pediatric dentist). But many of these children are too large for the small pediatric operatory chairs or must remain in their wheelchair or age out and outgrow the pedodontic office. This is where general dentists who are properly trained, motivated, equipped to handle the tasks and willing to accept what may be a less than usual and customary fee can perform a vital role in the health maintenance of these individuals. The work is not always easy, but all who work in our practice consider it always rewarding.

Informing the child's caregiver of what you are about to do at every step increases success. Only 25% of children with CP have a severe form. The remaining 75% are likely to be managed with relative comfort in an office setting. Simple, single direction with extra time allowed and patience generally leads to a successful visit.

In this section I will describe what we do in our office before we even examine the child, how we examine them, and how we treat them, both in the office and – when our office efforts don't succeed – under IV or general sedation in an operating room (OR).

Before Treatment

Oral Drugs

To improve the chance of successful dental treatment, we may ask that the parent or caregiver administer an oral sedative to the child before their appointment time.

Many sedative and hypnotic drugs have been used in the past century to provide sufficient relaxation so that the necessary dental work can be completed in the chair. Unfortunately, many of these drugs proved harmful and yielded a high morbidity and mortality rate. Sometimes it was the drug, sometimes the practitioner, and sometimes an idiosyncratic response of the patient. For a myriad of reasons, many drugs that were considered effective in the past have been removed from the market.

The benzodiazepines (diazepam, triazolam, midazolam, lorazepam, clonazepam, alprazolam) reduce muscle stiffness and control seizures, making them well suited for patients with CP and epilepsy. In my practice, aiming for the peak effectiveness of the drug to coincide with the time of the procedure on the mouth, I find that either triazolam (Halcion) or diazepam (Valium) elixir or pill 30 min pre-op is the most effective. All of our nondiabetic patients with special needs, including children with CP, arrive in our office on a 6-h empty stomach (except for medicine) and an empty bladder (unless they are wearing a diaper or pull-up). The benzodiazepines are smooth muscle relaxants in addition to being nonnarcotic hypnotic, sedative anticonvulsants. Urinating, defecating, and regurgitating are common after taking benzodiazepines, requiring the abovementioned regulations to prevent body-content accidents, or worse, vomit and aspiration.

Before administering or prescribing any sedative drugs, physically touching the patient, or beginning any dental treatment, we need a signed informed **consent**. The four main parts of our office consent form include financial agreement for treatment plan, chemical restraint (sedation drugs), physical restraint (wraps, props, and physical contact), and photographic permission (photos and videos).

Special precautions regarding sedation of children with CP:

- **The airway** must be carefully monitored during, as well as after, office sedation, whether given orally or by IV. Given the salivary pooling with an aberrant swallowing reflex, the chance of saliva, water, or other material entering the lungs is real and can be life threatening. Every precaution must be taken to protect the airway and prevent anything foreign from entering the lungs. See section on "Risk Factors" for more.
- **Idiosyncratic reactions** to benzodiazepines and other agents: Hypo-responders to a drug are rarely an emergent problem. However, hyper-responders may catch a health professional by surprise, off-guard, and ill-prepared to handle an unexpected response. Hypotension is a potential life-threatening concern. A reasonable approach to prevention is to follow the dictum of "dose low and dose slow." It is easy to give more drugs as needed. It is difficult or impossible to recall them once administered. Also, be sure to renew basic CPR for all clinical and clerical staff annually and PALS or ALS for the doctors biannually. Annual drill practice in an office provides an opportunity to identify and correct what might be fatal errors in an actual situation or crisis.
- **Seizures** are less likely if the child took a preoperative benzodiazepine as a sedative and anticonvulsant. Should a seizure occur, do not insert objects between the teeth. Rather, turn the patient or the head to one side and monitor the airway to reduce the risk of aspiration.

Caregiver in Room

Many dentists, especially pedodontists, prefer not to allow the parents or caregivers in the treatment room. Our practice is to invite the parent or caregiver into the operatory room for the following reasons.

1. If the treatment plan must be changed from, for example, a restoration to a pulpotomy or from a root canal to an extraction, the power of attorney (POA) responsible person is there to

witness, discuss, and authorize the change, since the informed consent may not have included this unexpected new procedure.
2. The parent can witness firsthand that the child may be screaming for no good reason other than he or she does not want to be there or have that needed dental procedure performed. Shrieks heard in the waiting room conjure mental images that are dispelled if the parent or caregiver is in the treatment room.
3. The presence of the familiar adult may prevent abandonment anxieties. The adult continuously reassures the child that everything is okay and no harm will come to them. This applies to our office as well as the first few minutes in the OR, before the child is asleep.
4. If dental X-rays are needed, the nonpregnant parent can don a poncho lead apron and assist.
5. The parent may provide one more set of hands to help immobilize the child, while the dental care is provided (Fig. 12).

Fig. 12 Parent in office assists with treatment

Special Operatory Chairs

Children with neuromotor or neuromuscular dysfunction require external support from seating systems to accommodate for compromised postural control and postural deficits (Neville 2005). Pelvic stability is required for the spine so that the neck is free to move. For children with CP, this is difficult in a dental pedodontic operatory chair and often impossible in a conventional larger adult operatory chair.

Seating solutions require a balance between the upright anatomical symmetrical posture of 90-90-90° of flexion of hips, knees, and ankles with the ability to function. There are anterior pelvic stabilization devices. In 1975, Cramer and Wright described the effective use of beanbag chairs for comfortably seating the child patient with CP. However effective, this never caught on as a popular method of patient seating.

In my office, we have multiple solutions for solving the posture dilemma. We place chair overlays to convert an adult into a pediatric chair instantly. A lightweight portable overlay immediately contours to the shape and position of the child. A mattress that conforms to the patient is also frequently used to provide placement, comfort, and support in seconds.

Smaller children may easily be transferred from wheelchair to operatory chair by caregivers and staff. We generally have the correct-sized body wrap already draped onto the chair. Larger patients may require two or more assistants to ensure a safe transfer in and out of the chair. Straight wood transfer boards are used when the wheelchair is alongside the operatory chair. If the two chairs are at 90°, we use a curved or quarter-circle-arched wooden board to slide the child over (Levy 2016a, b; Levy and Rotenberg 2016).

Many children prefer to remain in the comfort of their wheelchair. To accommodate that, we use our operatory chairs, which employ a cushion of air to glide the chair across the room, allowing the patient in the wheelchair to occupy the center of the room, permitting the dental professionals to perform their work with no crowding. The dentist, hygienist, and dental assistant can best work on a patient in their wheelchair if the large dental operatory chair is glided off to the side of the

Fig. 13 Patient remain in wheelchair during dental X-rays, operatory chair off to side

room and out of the way (Fig. 13). A free educational video is available at the following link: http://www.vivalearning.com/member/classroom.asp?x_classID=3043.

Safety Restraint

"Above all, do no harm" applies to the staff as well as the patients. Children with CP may flail their hands and kick their legs, either because they are physically unable to control their involuntary movements or they are intentionally acting out in an attempt to escape (Fig. 14).

When children with CP attempt to move in order to help, their muscles often tense up, increasing uncontrolled movements. Relaxation of the patient will not halt the uncontrolled body movements but may reduce their frequency or intensity. By anticipating the child's repetitive movements, one can adapt and avoid triggering aberrant muscular responses. Cradling the head

Fig. 14 Child in small portable chair overlay

and working slowly reduces uncontrolled movements. Avoiding sudden head turns or surprising stimuli such as noises, lights, or body movements into uncomfortable positions will guarantee a more successful visit (NIDCR 2014).

Some sensory tricks to suppress unwanted movement include the following (Cerebral Palsy Alliance):

- Touching the face or chin with a hand or finger
- Resting the back of the head against a wall
- Tucking a hand under the chin
- Placing a hand behind the back

Straitjackets, restraining boards, and immobilization devices have been used for centuries to restrict patients' movements and prevent flailing and kicking. Whether these movements are voluntary or involuntary, they preclude good, safe, and quality dental treatment. The current trend is to avoid any device that may itself cause physical injury. Yet, the restraining mechanism must prevent unwanted head, hand, feet, and torso movements.

While many outdated restraining devises and tools are still in use, our practice limits this necessary restraint to Velcro®, mesh cloth, and hands. The operatory chair or the wheelchair headrest is the base for the first plane of movement, which is restricted. We assign one dental professional to immobilize the patient's head in the remaining five planes using both their hands and forearms.

Fig. 15 Body and legs restraint with rainbow wrap and knee guard

It is crucial to immobilize the head. The goal is to prevent the child from jerking his or her face into a needle, drill, scaler, explorer, or any sharp tool. It is important to keep instruments and equipment out of the patient's way and to maintain a clear path for the patient's potential spastic movement throughout the dental procedure.

This manual restraint is often used in addition to a piece of Velcro® wrapped around the patient's forehead and the operatory headrest itself. A larger piece of Velcro® is wrapped around the patient's knees or ankles or both, often circling part of the chair as well. A colorful, non-threatening wrap, made of mesh and Velcro® that includes two cloth wrist bracelets, prevents most children from causing disruptive movements of limbs or torso (Fig. 15).

The wrap may be placed on the operatory chair or onto a parent/caregiver's lap before the child is seated on it. Younger patients will perceive this wrap as a comfortable snuggly often used by parents for feeding or transport. For older children with CP, the wrap, coupled with sedative drugs or nitrous oxide or both, results in a 96% success rate in successfully completing the assigned dental procedure.

Special precaution regarding safety restraints: Helmets should only be removed when it is deemed "safe," such as when the child is held by a caregiver or surrounded by pillows. Keeping the hands away from the mouth where there may be sharp tools will prevent accidents. The child's hands may be held by a caregiver if the child is large or strong.

Nitrous Oxide

Once the premedicated patient is seated and restrained, we may administer a mix of nitrous oxide/oxygen (known colloquially as laughing gas). Introduced by Wells in 1884, nitrous oxide demonstrates a rapid onset, quick recovery, and minimal side effects, making it an excellent choice for patients with CP. Nitrous oxide/oxygen leads to reduced hyperkinesis or decreased movement during dental treatment. The reduced response to pain stimuli is comparable to 15 mg morphine (Kaufman et al. 1982). As a result, extensive dental work can be performed, while the child is sedated and quiescent.

Yoshida et al. (2003) noted that nitrous oxide reduced the orofacial muscle tonus of children with CP, because of the gas's inhibiting function on CNS, making it a useful adjunct during office dental treatment.

Jensen (2008) found the use of 70% nitrous oxide with 30% pure oxygen results in significantly reduced movements (Sehrawat et al. 2014). My personal observations and treatment of over 35,000 special-needs patients under nitrous oxide in my dental office, which included many hundreds of children with CP, support Jensen's findings (Levy 2016a, b; Levy and Rotenberg 2016).

The new low profile nitrous oxide mask has replaced all the old masks in our office. With four different sizes of disposable nitrous oxide masks, the profile is so low that patients are now able to wear their glasses with no interference from the mask. Additionally, for the older teens with facial hair, there is no gas leakage under the nose. Two of the three sides of the clear, disposable mask have peel-off adhesive strips that preclude gas escape from either side of the nose. At the open nostril area, nitrous oxide enters into the right side, and exhaled air exits the left. To make the mask appealing to our children with CP, we determine their favorite flavor or scent. We then coat the lining of the mask with that scent or flavor. We also write their name on the mask for them to take home as a souvenir of their successful office visit (Fig. 16). Nitrous oxide is typically used in conjunction with oral sedation drugs on children who

Fig. 16 Silhouette nitrous oxide mask with mouth gag

are body wrapped and have an empty stomach and bladder.

Opening the Mouth

Hippocrates was correct when he said, "before you can treat, you must diagnose." In this context, for dental evaluations, he left out, "and before you can diagnose, you must be able to open the patient's mouth." Whether a child is fearful from an unpleasant past experience, or a first-time patient is afraid of the unknown, children with CP may present a challenge to a dentist. However, this is a challenge that can **always** be handled with a professionalism that may even mitigate future treatment issues.

Dos Santos and de Oliveira (2004) used cryotherapy on masseter muscle spasticity to obtain the mouth opening required for oral hygiene and dental treatment. Ice on the masseter obtained a temporary reduction in spasticity, facilitating access to the occlusal and palatal surfaces of the upper molars.

In our office we use a different technique, primarily based on my original research, much of which is viewable on a free 1-h educational webinar titled, "How to Open ANYONE'S Mouth." This video is available at the following link: http://www.vivalearning.com/member/classroom.asp?x_classID=3101.

In over thousands of attempts to safely open the mouth of children with CP, we have been successful in the office 96% of the time. The other 4% were deemed not safe or potentially harmful either physically or psychologically. Those patients were examined and treated under safe conditions via outpatient general anesthesia in a hospital or surgical center operating room. More about this follows in the section on general anesthesia (Levy 2016a, b).

The basis of successful mouth openings in the office for uncooperative children with CP is to precede the attempt by using benzodiazepine drugs or nitrous oxide or both. For safety, the child is also placed in a colorful non-threatening body wrap made of mesh and Velcro®. Once the drug or nitrous oxide or both have taken effect, the child's head is immobilized. A dental professional places one hand on the forehead or under the nose to prevent unwanted downward head movement. Then, the dentist presses one of the four recommended acupuncture points to gently "pressure" the mouth open. The momentary discomfort to the child is considerably less painful or traumatic than a quick injection anywhere in the body. For a resistant child, a physical distraction technique may be employed to divert his or her attention away from the mouth-opening procedure. This may include pressing the thumb fingernail at 90° to the bed of the nail or rubbing the philtrum horizontally or even a gentle but unexpected slap to the forearm. The moment the physical distraction is performed, the acupressure point is activated by a second person at the site's proper angle and direction.

The points that I have developed, routinely employ, and now teach are the following:

(A) Conception (CO or CV) -24 the mandibular chin button
(B) Miscellaneous Head and Neck (MHN) -18 mental foramen or foramina

Fig. 17 Opening mouth with CO-24 pressure point and Open Wide Mouth Rest – horizontal

(C) Triple Warmer (Triple Burner, Triple Heater) (TW) -17 under the ear, near the TMJ
(D) Governor (GV) -26 maxillary philtrum

Activation is successful only if the correct angle, direction, and mode of contact are used. For example, CO-24 must be vibrated with a knuckle at a 45-degree angle in and downward. MHN-18 also requires firm vibration 45° in and down, be it unilateral or bilateral. TW-17 requires horizontal pressure from rear to front (Fig. 17). GV-26 is activated by a horizontal rubbing action (see webinar noted earlier in this paragraph). It is essential that before prescribing or administering any drugs or nitrous oxide or utilizing physical mouth-opening techniques, proper signed informed consents **must** be obtained (Levy 2011a, b).

Keeping the Mouth Open

Santos et al. (2016) found that a low intensity laser aimed at the TMJ and muscles of mastication increased the amplitude of mouth opening and decreased tonus of children with spastic CP. Once the mouth is opened, the task is to keep it open long enough to at least perform an oral exam and preferably to complete the anticipated dental treatment. A high level of patient cooperation may not be required to perform a simple oral evaluation and exam. However, if a needle, drill, scaler, or other sharp tool is to be placed in the mouth, it is prudent to assure that it can be done safely. Mouth props, mouth rests, mouth gags, or other devices sustaining oral access are essential. The tools used to initially open the mouth may not always be the best ones to sustain or expand that opening.

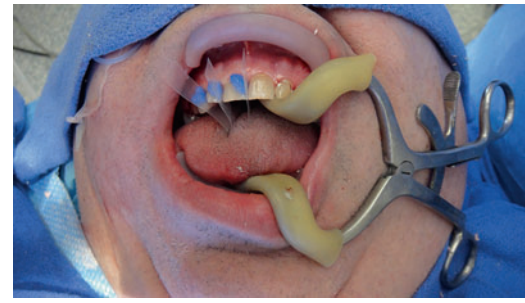

Fig. 18 Keeping mouth open – with mouth gag in OR

Once we have successfully opened the child's mouth by either asking, coaxing and encouraging, pinching the nose shut, or using acupressure, the mouth must remain open for as many minutes as it takes to complete the procedure. Whether it is a quick exam, an intermediate cleaning, or a lengthier dental procedure, the mouth must not be allowed to close at a time or manner that will cause problems or injuries. We insert a wood-covered-in-foam prop on one side of the mouth as far posteriorly as possible. A second person then inserts an expanding mouth prop or mouth gag on the other side, then slowly ratchets it open until maximum opening is reached. A finger is placed on the prop's hinge to prevent dislodgement, as the wood/foam mouth rest is removed. The dental work is then performed on the free side that is exposed and available. One may insert a rubber dam or other isolation tool. When the work is completed on that half of the mouth, the opposite side of the mouth is propped to its widest vertical dimension, as the existing prop, gag, or mouth rest is removed. For patients with TMJ, we remove and reinsert every 15 min to prevent joint fatigue. For all others, we prefer to prop the second side before removing the first to prevent premature mouth closure.

For the 12 anterior teeth, a bilateral mouth prop is often used, sometimes with a lip retractor. This device gradually forces the mouth open just like the unilateral mouth gag and is found in ENT catalogues (Fig. 18).

Fig. 19 Portable head light in hospital pre-op area

Treatment: Oral Exam and Cleaning

Every oral exam and cleaning with possible radiographs, and every dental treatment, begins with our inserting a foam and wood rest. The insertion is followed by the techniques described in the section on "keeping the mouth open." To conduct this exam, we use several tools.

Illuminating the Oral Field

Many children with CP are in perpetual motion, challenging the dental professional forced to work in confined conditions. The child's head darts in and out of the area illuminated by overhead fixed operatory lights. One way to overcome that is for the operator to wear a headlight, allowing constant illumination of the mouth by simply rotating the forehead to mirror the child's movements. We use featherweight lights, since they can be affixed to one's own glasses or to clear plastic safety glasses. The rechargeable and portable light source can be used in any venue (Fig. 19).

Illuminating Inside the Oral Cavity

Once the child's mouth is opened and safely propped open, we generally begin our intraoral exam using a portable, lightweight, three-in-one device: a long-handled mirror, a mouth prop, and a light source. This device also enables us to observe soft tissue asymmetries and has already detected several mouth cancers (see free educational video

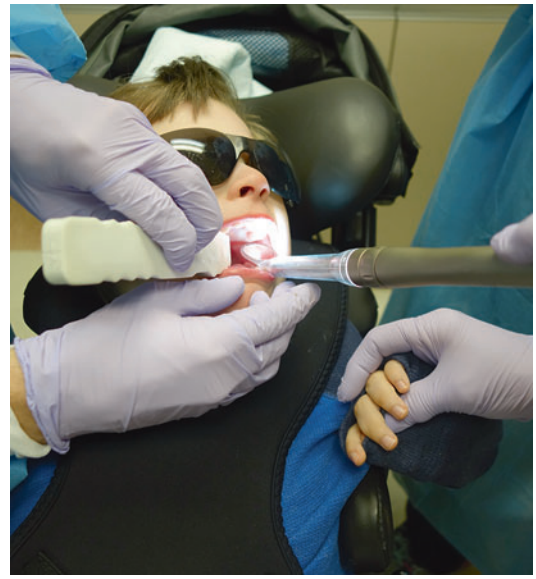

Fig. 20 Light in mouth of propped-open child with vertical Mouth Rest

available at the following link: http://www.vivalearning.com/member/classroom.asp?x_classID=3042). When one side of the mouth is fully examined, we switch the mouth gag to the opposite side or insert another prop on the second side before withdrawing the first (Fig. 20).

Intraoral Photos and Video

Intraoral photos are taken of the mouth and immediately displayed onto the TV screen in the room. This allows us to see still images of what were moving targets a moment ago. It also allows us to more effectively show the parent or caregiver what the child's mouth looks like, be it to educate, praise, or show areas in need of attention. If the child is too animated for still shots, we insert our video camera for intraoral videos, knowing we can freeze frame later to isolate any individual frames that will be useful for diagnostic, archival, communication, or insurance purposes. Often, we print out selected images to give the family to take home as reinforcement souvenirs or to communicate with caregivers not present (Fig. 21).

Fig. 21 Intraoral camera in propped-open mouth of an uncooperative 5-year-old boy with CP using mouth gag

X-Ray Imaging

We never treat any patient without first viewing the radiographs, but such images are not always attainable during the initial visit. We often have the child stand up or prop his or her head in a wheelchair to attempt panoramic images. Our panoramic X-ray machine also can take extraoral digital bitewings for children who cannot readily tolerate intraoral films or sensors (Fig. 22). For gaggers or uncooperative children, we may anesthetize the mouth with a spoonful of 2% lidocaine elixir or a topical spray. We invite any nonpregnant caregiver or staff member to don a poncho lead apron and remain in the room to immobilize the child's head, hold the sensor or film, or provide comfort. Though each treatment room has a wall-mounted X-ray head, we also frequently use portable 5.5 lb. X-ray units, which can be used in our office, in the OR, homes, hospice centers, and other off-site facilities or locations. Since the lead-aproned operator shoots the image with one hand while holding the sensor or the patient's head with the other, the handheld X-ray units provide images in less time than a wall-mounted unit. Retakes can be instantaneous for imperfect initial images.

The 4% of cases in which radiographic images were not successfully obtained in the office are **always** successful when the patient is treated while asleep in the OR (see section on "General Anesthesia"). On the rare occasion that our sensor or computer is inoperable, we dare not continue the case without an adequate radiographic image. That is when the self-developing dental film saves the day and allows us to complete the case that session. This free-standing dental film allows us to take excellent radiographs within 60–90 s, without delaying or canceling the case (Fig. 23). This is crucial whether in the OR under general anesthesia or out in the field at a home, institution, hospice center, dental mission work to other countries, or other off-site venues.

Fig. 22 Dental X-rays in OR

Fig. 23 Dental X-rays in OR with self-developing dental film

Fig. 24 Magnification loops plus light while inserting nasal spray anesthetic

Magnification

My three partners and I all have different eyes and different preferences regarding magnification. I often use a headlight combined with a magnification lens, finding it comfortable to wear whenever I need an enlarged and illuminated detailed view of the mouth. Others may prefer a magnifying lens only (Fig. 24).

Isolation

The dentist needs to isolate the tooth being worked on from saliva and the soft tissue of the mouth, and especially in the case of children with CP, from inadvertent aspiration of fluids or foreign objects. To drill teeth or place composite restorations in a propped open, well-lit, clear, and dry intraoral environment, we consistently find Isolite® most effective. Isolite® is a disposable, soft-plastic, multi-sized, easily trimmed, readily placed mouth prop that has five levels of intraoral light and two levels of suction (high velocity evacuation plus saliva ejector) (Fig. 25).

Composite or sealant failures are rare when Isolite® is placed in the mouth. For gaggers, we apply 2% lidocaine viscous around the appliance. For smaller mouths or mandibular tori, we cut off any excess plastic with scissors.

Treatment: Complex Dental Procedures

Children with CP may suffer from substandard home dental care, requiring complex dental procedures such as restorations, crown and bridge, or teeth extractions. In this case, after the patient is seated, restrained, sedated, and propped, anesthesia is required. We start with a topical anesthetic, followed by a local anesthetic.

Fig. 25 Isolite retractor, suction, prop, and light

Typically the local anesthetic is administered with a needle, but there are other options. Tetracaine HCL and oxymetazoline HCL, a nasal spray, can be used instead of local anesthesia for the ten upper front teeth, both primary and permanent. Two doses are sprayed into the one nostril closest to the teeth being worked on (Fig. 26). This eliminates the need for any injections in 96% of the cases for the upper eight front teeth and 64% of the upper second premolars (St. Renatus, LLC 2016a, b, c; US Food and Drug Administration 2016).

The most common time for any patient to bite their locally anesthetized lip, tongue, or cheek is right after any mouth props are removed, after the dentist completes the procedure. While the numbing effect of the anesthetic may last for many more minutes after the procedure concludes, it is within

Fig. 26 Tetracaine and oxymetazoline nasal spray used to anesthetize 10 upper front teeth

Fig. 27 Phentolamine mesolate to reverse numbing effect of local anesthetic

the first few minutes that a patient may explore the unusual sensation of biting their lip, tongue, or cheek without feeling any pain. Children with CP may be especially prone to this problem if they don't understand the potential harm or are not warned. To prevent this potential self-injurious behavior, the dentist can inject phentolamine mesylate, a vasodilator that hastens the return to normal sensation, in the area numbed by the local anesthetic (Fig. 27).

When Office Efforts Don't Succeed

When the combination of oral sedation drugs, nitrous oxide, and restraints is applied, our success rate in the office is 96%. For the 4% we are unable to safely treat in the office, we can bring our success rate up to 100% by using either IV sedation or general anesthesia in an operating room.

For a dentist, there is nothing more efficient and effective than treating a patient who does not move at all. This is especially true for children with CP, who can receive the finest dental care with no psychological harm of being restrained, no chance that their behavior might preclude finishing the planned treatment, and under the safest conditions. In the OR, all the planned work is done in one session, without having to schedule multiple office visits, where case completion is never assured. Going to the OR is the last, not the first, choice. The upside is the dentist does his or her finest and most-efficient, accurate work on a patient who cannot halt or remember the dental treatment.

In the office, a dentist cannot guarantee that any dental procedure would be completed that day as planned or hoped for. There are too many variables that may preclude successful completion, especially given the child's physical and behavioral issues. In the hospital or surgicenter OR, all cases can be completed that same session, even if the specific procedures were modified based upon new information from the intraoperative visual exam and radiographic findings. For extractions, we always use resorbable sutures rendering suture removal optional rather than a possible struggle. Restorations are placed with no saliva contamination or movement by the patient. In addition to stainless steel crowns, we now have composite crowns, which do not require computer-aided design/computer-aided manufacturing (CAD/CAM) for same day completion. For immediate delivery of space maintainers or removable appliances, the absence of the child's head movements makes the dentist's job much easier. If a complex procedure beyond the skill or scope of the treating dentist is required, a specialist is invited to cooperate. That is also a perfect time for any tests to be performed that are difficult

on an awake patient. This includes blood draw, pap and pelvic exams, chest X-ray, EKG, and procedures by allied health professionals such as cardiologist, ENT, or pediatrician. This is in the true spirit of efficient, practical, successful one-stop health care and cooperation (Levy 2016a, b).

IV Sedation

The intermediate between nitrous oxide with oral drugs and intubation with general anesthesia is IV sedation. For dentists, each state has different rules and regulations for obtaining office sedation permits. In most states, a class 1 permit is required for moderate office sedation. A class 2 permit is required for IV or deeper moderate sedation. A class 3 is required for general anesthesia. Oral surgeons generally have permits that allow them to monitor their own cases. Most pedodontists and general dentists rely on dental anesthesiologists, nurse anesthetists, or anesthesiologists to manage the patients' heart, lungs, and vital signs, while the dental professionals do what they do best – their dentistry. The ASDA, ADSA, private groups such as DOCS, and many dental schools are among organizations that help provide training for dentists seeking to provide anything more than mild-to-moderate nitrous and oral office sedation.

General Anesthesia

Children with CP take slightly longer to wake up after general anesthesia. It is common for ASA III and IV patients not to go home the same day, as additional monitoring may be required to detect and treat complications of general anesthesia because of their underlying disease (Escanilla-Casal et al. 2014).

Loyola-Rodriguez et al. (2004) reported excellent results using sevoflurane and propofol, documenting a postanesthesia recovery time of 20–40 min in children with CP.

In the hospital or surgical center, Versed (midazolam) elixir is often given to any patient who does not readily allow an IV to be started. It is mixed in a drink or squirted into their mouth with a plastic syringe. Combative patients may also require an intramuscular injection of ketamine IM (2–4 mg/kg), a narcolept-analgesic, which subdues a patient for staff to start an IV and prepare the patient for general anesthesia. Once asleep, the child is compliant, allowing the dental team to perform quality dental care on a non-moving patient (Fig. 28).

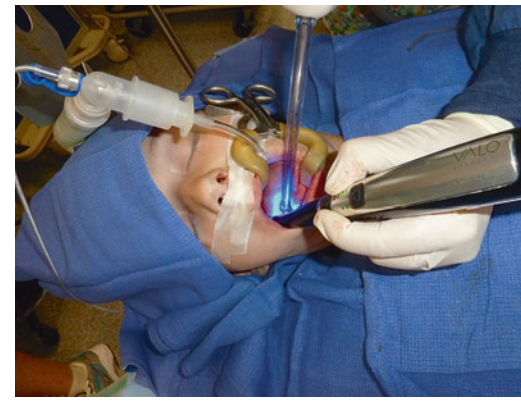

Fig. 28 Comprehensive dental care while asleep in the OR

OR (Operating Room) Follow-Up in the Office

After treatment in an operating room, I always recommend a follow-up visit in the office, generally between 2 and 14 days postoperatively. All the tools, techniques, and tips we employ for the preoperative OR visit may be used for the postoperative evaluation. This brief follow-up visit may be necessary to remove sutures; assure that resorbable sutures are out; check on postoperative healing of a surgical site; confirm that there are no high restorations; cement crowns, bridges, or space maintainers; adjust appliances delivered in the OR; and more. The visit is also an excellent opportunity to review and modify the child's oral hygiene procedures.

Oral Hygiene at Home or Institution

Dental care begins at home, with tooth brushing; flossing, fluoride, therapeutic agents such as chlorhexidine, and alternatives such as Waterpik,

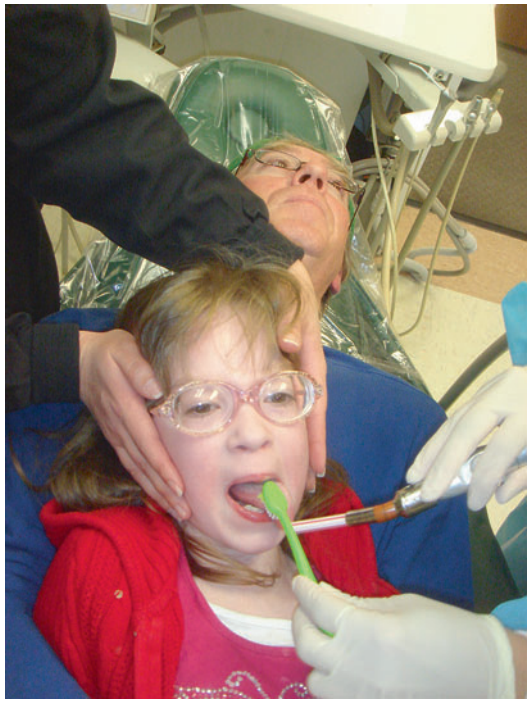

Fig. 29 OR follow-up, teaching oral hygiene

water floss, and other adjunctive oral aids. Oral exams in the dental office are meant to assess home care, evaluate any new dental conditions or pathology, and treat them accordingly.

If a regular toothbrush is not succeeding in removing plaque because of the child's non-compliance or lack of cooperation, plan B should include an electric toothbrush, whose bristles are moving even when the caregiver's hand is not. If the child doesn't accept the floss with your fingers, try using a floss holder or sling-shot-shaped handle. If that is not possible, consider a water pick, being mindful of potential aspiration concerns. One modality that has very little downside is 0.12% chlorhexidine (CHX) mouth rinse. Maiya et al. (2015) had excellent results with daily CHX 0.2% spray in maintaining satisfactory oral hygiene and gingival health.

Francis et al. (1987) used CHX spray, gel, and mouthwash. Although the gel was the most effective in reducing plaque and gingival bleeding, the caregivers' poor compliance precluded that modality long term, favoring the daily spray instead.

Soncini and Tsamtsouris (1989) explored and maintain that individually modified toothbrushes (IMT) are effective in improving the oral hygiene and gingival health of children with CP. Damle and Bhavsar (1995) also reported a marked decrease in plaque levels for children with CP who used toothbrushes with modified handles under supervision.

Hygienists are very creative in suggesting modifications to the child's toothbrush. In our office, we have used all of the following: toothbrush in a tennis ball, in a Styrofoam ball, in a bicycle handle, wrapped in play dough, glued to a Velcro® strap, secured to a 12″ ruler, attached to multiple rubber bands, and more (Fig. 29).

Training for Dentist and Dental Staff

Every teacher knows that the best way to learn anything is to have to teach it. Dentists, hygienists, and assistants are all obliged to teach patients and caregivers both proper as well as modified oral hygiene. The techniques must be individualized and varied. Basic oral hygiene knowledge and skills are taught in the academic clinical didactic programs. It is in the office and the field that creativity reigns, and customized oral hygiene instruction protocols are developed. Experience and repetition grow novices into experts, who help train the next generation of dental health professionals.

Most dental meetings and universities include participation courses on management of patients with special needs. Self-study courses are available, including YouTube and many excellent self-directed online programs. There is nothing more effective than a quality participation course followed by incorporation of these techniques into one's practice slowly and steadily. Though more difficult to come by, mentorships are excellent but require that the student clinician already have basic necessary knowledge and skills. Many dentists are pleased to share their knowledge and experience if only asked, so consider asking.

Access to Care

Many parents whose children with CP were on Medicaid perceived cost as a barrier to dental care (Schultz et al. 2001). Al-Allaq et al. (2015) are some of many authors who contend that dental schools should better prepare graduates to meet the demands and needs of patients with CP and other special needs.

Casamassimo et al. (2004) noted that only 10% of dentists saw special-needs patients often or very often during their training. Only 25% had any hands-on experience in school. Postgrad General Practice Residencies and Advanced Education in General Dentistry programs made no difference in terms of seeing patients with special needs once in practice. Dentists with hands-on experience did not consider the patient's level of disability or behavior as obstacles to care. I view the primary barriers to access to care as **fear and finances**. The fear factors can readily be overcome by some professional knowledge and motivation. No child should be denied dental care because of the dentist's level of comfort. Learning to successfully treat children with CP is no different than learning any other dental skill. Most state and national dental meetings as well as dental schools offer such workshops, in addition to online training. The unmet needs of these children could easily be met if every dental office opened its doors to greet and welcome these children.

There is much literature describing and confirming the assertion that finances are a major obstacle to seeking and obtaining dental care for these children. The articles appear similar in nature and conclusions yet originate from many different countries (Schultz et al. 2001; Maiya et al. 2015; Vujicic 2014). In the USA, there are federal, state, county, and private programs to assist those who seek either elective or urgent dental care. Other financial resources and safety nets for needed dental care include Donated Dental Services programs, Gray Area Access programs, Missions of Mercy, Religious Coalitions, Foundations for the Handicapped, Hospital-affiliated dental clinics (to reduce ER visits), and funds through service organizations and clubs.

Conclusion

As patients in a dental office, children with CP often present challenges that require patience and creativity on the part of the dental team. Treating these patients is easily achievable if the staff is open to working with this population and becomes passionate about access to care. All it takes is a bit of special equipment and, more importantly, the willingness to make some adaptations to usual and customary dental office protocols.

An essential part of dental care for children with CP is preventive. Practitioners who are able to creatively tailor brushing and flossing procedures to each patient, and who find alternative and effective ways for a patient to regularly practice oral hygiene, reduce the need for expensive and possibly traumatic dental treatments.

Case Studies

Case Study #1: Laura

Laura was first seen as a 12 year old white female with CP, seizure disorder, Intellectual disability, heart murmur, and combative behavior. She had a class 2 malocclusion, with her front teeth grossly flared out. She was uncooperative with daily oral hygiene, and needed to be sedated with oral drugs and nitrous oxide to have any office dental care. She was wheelchair-dependent and on 25 different daily medications.

On her initial office visit in 1998, in addition to the standard amoxicillin 2 grams premedication for a cardiac condition, we used chloral hydrate 500 mg, hydroxyzine (Atarax) 20 mg, plus nitrous oxide/oxygen 50% to evaluate small fractures on teeth #8 and #9, her upper front central incisors. Given her unsafe thrashing body and hand movements, we restored her teeth a week later with composite material

(*continued*)

Case Study #1: Laura (continued)
after increasing the dose to chloral hydrate 1 gm and hydroxyzine 30 mg, with nitrous 70%, plus the 2 grams of amoxicillin (Fig. C1.1).

Four years later, at age 16, she fell down and fractured teeth #8 and #9 again. After monitoring for two weeks noticing they became dark and mobile, we removed the teeth, and prepared a fixed porcelain/metal bridge via out-patient general anesthesia in the hospital operating room. The family wanted to replace the non-salvageable teeth, but we all agreed that Laura was not a candidate for implants or removable appliances. The bridge that we prepared in the hospital OR was cemented in our office 2 weeks later using the same sedation regime as before. Bridge oral hygiene was reviewed with the parents, and Laura was placed on semi-annual dental hygiene recall (Fig. C1.2).

Case Study #1: Laura (continued)

Years later, in 2009, Laura fell and fractured the bridge (Fig. C1.3). Again, she was taken to the OR where a new 6-unit bridge was prepared, and also cemented in the office with maximum premed, oral sedation, and nitrous oxide (Figs. C1.4 and C1.5).

Two years later, Laura fell again, breaking the second bridge (Figs. C1.6 and C1.7). The same cycle repeated, whereby a third bridge was prepared in the hospital OR (Figs. C1.8 and C1.9) and cemented in the office (Fig. C1.10) using the same props and sedation

She has been on semiannual hygiene visits ever since and remains an active patient who is wonderfully managed by her loving parents at home. She is still sedated, wrapped, and propped when receiving both elective and urgent dental care in our office and hospital. The third bridge is holding up just fine (Fig. C1.11).

Fig. C1.1 Laura age 12, before and after composite upper front teeth repair

Fig. C1.2 Laura age 16, before and after upper front teeth bridge placement

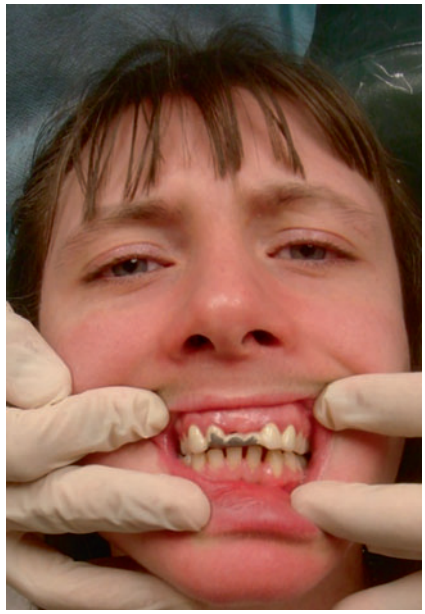

Fig. C1.3 Laura breaks 6 upper front teeth bridge

Fig. C1.4 New bridge is placed in mouth

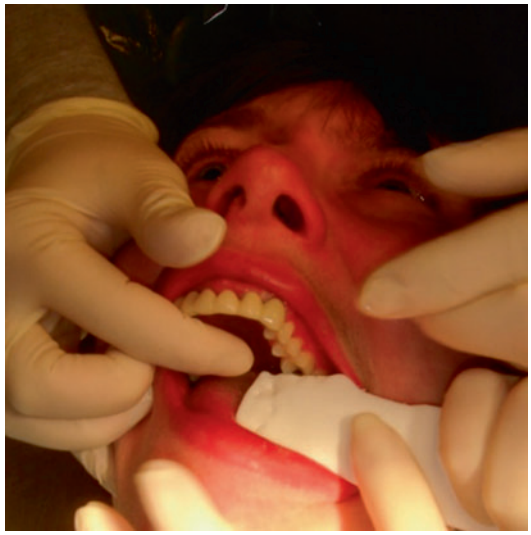

Fig. C1.5 New bridge is cemented into propped-open mouth

Fig. C1.7 Broken second bridge

Fig. C1.6 Laura falls and breaks second bridge

Fig. C1.8 Laura is in OR to have broken bridge remade

Fig. C1.9 New bridge being prepared in OR

Fig. C1.10 New bridge is cemented and flossed in office

Fig. C1.11 Laura with third six-unit upper front teeth bridge

Case Study #2 Svetlana

Svetlana is a 19-year-old white female initially seen with decayed and fractured upper front teeth (Figs. C2.1 and C2.2). She constantly drools, has CP and a seizure disorder, is intellectually delayed, non-verbal and wheelchair-bound. Her family wanted us to save all teeth except for the impacted third molars. In the OR, we placed composites and crowns on the upper front teeth, and restored other carious teeth (Figs. C2.3, C2.4, C2.5, C2.6 and C2.7). Two weeks later, with Svetlana remaining in her wheelchair, and with her family's support, we cemented the two upper right incisor crowns, and reviewed oral hygiene home care (Figs. C2.8, C2.9, C2.10, C2.11, C2.12 and C2.13). Semi-annual office follow-ups thereafter required only simple office cleanings (Fig. C2.14).

Svetlana does not require any sedation other than an anticonvulsant, but requires mouth props to prevent inadvertent closures. She always wears a towel to catch her drool (Figs. C2.1 and C2.13).

Fig. C2.1 Svetlana, age 19 with bandana to catch drool

Fig. C2.2 Four upper front teeth decayed

Fig. C2.3 Better exam in OR shows dental caries

Fig. C2.4 Intraoral images taken in OR

Fig. C2.5 Portable handheld X-ray unit with sensor

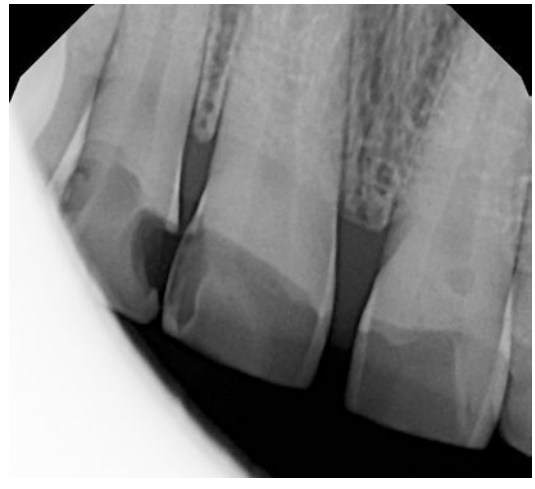

Fig. C2.6 X-rays show decayed upper front teeth

Fig. C2.7 Crowns are prepared for upper right incisors, composites on the left

Fig. C2.8 Svetlana returns to office for 2-week follow-up

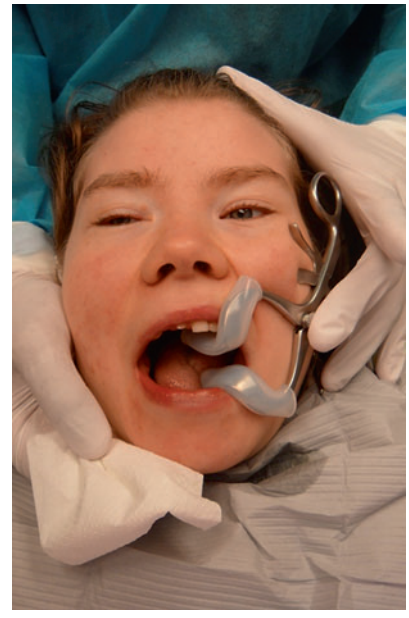

Fig. C2.9 Svetlana's mouth is propped, and all OR work is checked in office

Fig. C2.10 Mother assists, while we cement the crowns

Fig. C2.11 Porcelain/metal crowns teeth #7,8 in place

Fig. C2.12 Flossing away excess cement and instructing family

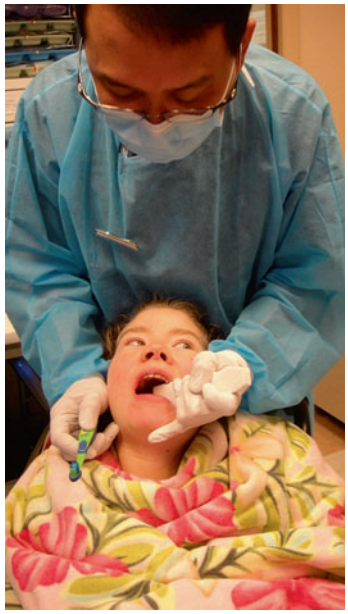

Fig. C2.13 Teaching oral hygiene to patient and family

Fig. C2.14 1-year follow-up

Case Study #3 (Allison)

Allison is a 15 year old wheelchair-bound female with cerebral palsy and a severe anterior open bite (Fig. C3.1). She is wheelchair bound, and has a history of a spinal fusion. Her non-compliant behavior precludes effective daily oral hygiene. In our office, we noticed over-retained primary tooth #H, and assumed there may be an impacted upper left cuspid #11. The calculus from her periodontitis was very think and tenacious. She was unable to hold her head still to safely have the necessary treatment in our office. She is g-tube fed, which promotes calculus build-up.

After their pediatric dentist retired it took the family 1.5 years to find a dentist and facility who would agree to treat Allison.

After an initial limited office exam, we successfully treated her in the hospital OR with a thorough dental exam, full set of intra-oral radiographs, removal of the dangerously loose baby tooth and removal of the heavy calculus deposits (Fig. C3.2). Exam and radiographs showed malocclusion with crowding and the impacted upper left cuspid with the over-retained primary cuspid (Figs. C3.3 and C3.4). Allison is now on a regular 3-month office cleaning cycle via Valium oral sedation in our office.

Fig. C3.1 Allison showing severe anterior open bite, protruded upper teeth, with incompetent lower lip

Fig. C3.2 Allison with widely flared upper anterior teeth and open-bite malocclusion

Fig. C3.3 DEXIS X-ray images while asleep in OR, via nasal intubation

Case #4 Savannah

Pt is a 19-year-old white female with a pronounced orthodontic class 2 division 1 (Figs. C4.1, C4.2 and C4.3). She has cerebral palsy, is intellectually disabled, and has had seizures since age 1. She walks slowly on her own power, but with a spastic gait. She is non-verbal, but uses a computer to verbalize whatever she wants to say. She bumped her front teeth several times, and has a darkened upper left front tooth #9. She has difficulty cleaning her mouth, and cannot maintain her mouth open for more than a few seconds at a time in a dental office, despite her best intentions to cooperate.

We performed a thorough visual and radiographic evaluation plus all needed dental treatment via out-patient general anesthesia in the OR (Figs. C4.4 and C4.5). Routine frequent office cleanings are now performed with a mouth prop, plus 20 mg oral Valium and nitrous oxide to relax the mouth muscles.

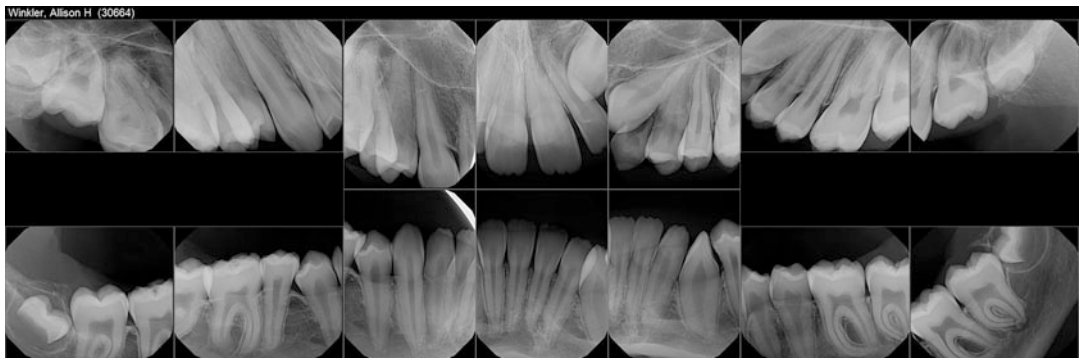

Fig. C3.4 Full series intraoral periapical images show impacted tooth #11, upper left cuspid

Fig. C4.1 Savannah age 19

Fig. C4.2 Upper teeth show copious saliva and malocclusion anterior open bite

Fig. C4.3 Lower arch shows crowding and periodontal disease

Fig. C4.4 Savannah selects her favorite flavor of Lip Smacker to line her mask

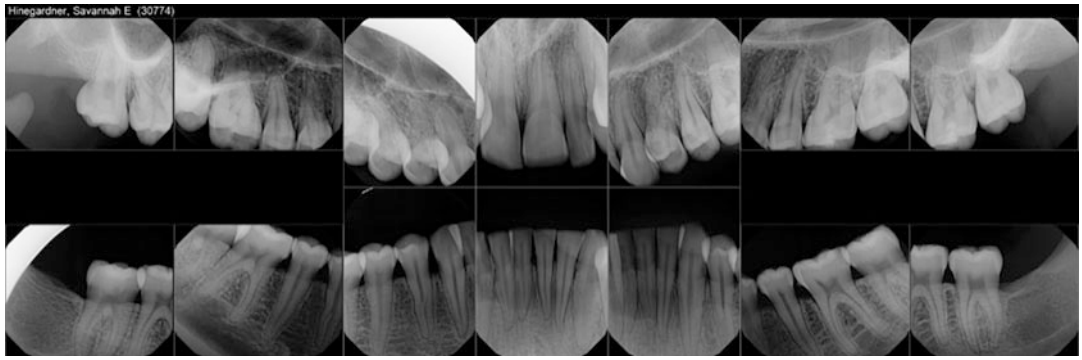

Fig. C4.5 X-rays taken in the OR that were unattainable in an office

Case #5 Maria

Maria is an 18-year-old wheelchair-bound girl who suffered anoxic brain injury plus cardiac arrest and septic shock as an infant (Fig. C5.1). Her current problems include spastic quadriplegic cerebral palsy, Lennox-Gastout Syndrome causing intractable epilepsy, Hirschsprung's Disease, spinal fusion for neuromuscular scoliosis, abnormal thyroid, anemia, esophagitis due to GERD, hypertension, developmental delay, feeding difficulty, and hip subluxation. She is g-tube fed and has a colostomy. The severe jerky movements of her limbs have precluded her from having dental care, and she has been on wait lists, without ever being called. She has never had any dental radiographs, but her loving and attentive father felt she might have dental caries and periodontitis (Fig. C5.2). Unable to obtain any dental x-rays in our office, we agreed to take x-rays, examine and clean her teeth in the OR as well as restore decayed tooth #30. Despite clearance from her neurologist, hematologist, pulmonologist and primary care physician, the anesthesiologists at the only hospital in our town refused the case, citing she was too high a risk for elective dental care.

With no other options, we treated the patient in our office using oral Valium 15 mg and continuous high velocity vacuum suction. The hygienist and I cleaned Maria's teeth and I performed a composite restoration on tooth #30, propping the opposite side.

Despite our best efforts, Maria later developed lung congestion and was hospitalized for a month with aspiration pneumonia. The father did not want to tell us, fearing we would no longer be willing to treat her in our office.

Maria and her father still come in for cleanings every 3 months. She remains in her wheelchair while her father entertains her with her favorite i-pad songs (Fig. C5.3). We still have not been able to obtain any x-rays, but visual exam suggests there are no further dental caries (Figs. C5.4 and C5.5). Our Cari-Vu exam suggests no decay. We cannot determine impactions or other subgingival dental pathology, but continue to clean her teeth with bilateral high velocity suction every 3 months to prevent aspiration. We consider it a privilege to be able to offer Maria and her father dental care in our office (Fig. C5.6). We plan to treat her in the hospital OR when the anesthesiologists determine it is safe enough to be considered a low risk.

Fig. C5.1 Maria, age 18

Fig. C5.2 Maria's left stained teeth, crowded anterior open bite

Fig. C5.3 Maria's father sits in the operatory chair, while she remains in her wheelchair

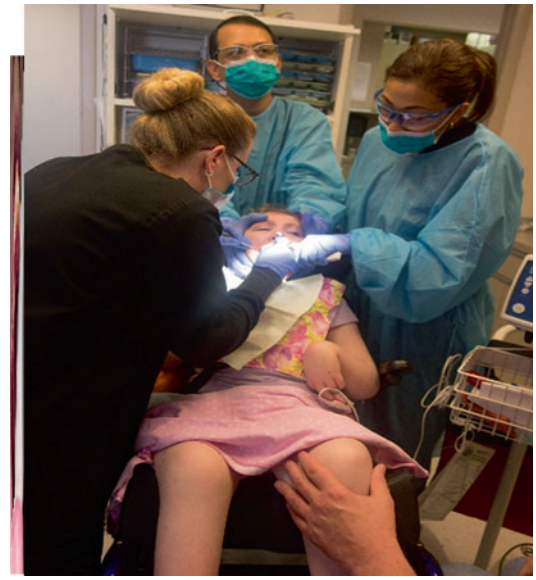

Fig. C5.4 Hygienist cleans Maria's teeth with two assistants and father helping

Fig. C5.5 Close-up of foam and wood mouth rest

Fig. C5.6 Maria is rewarded with a kiss from her dad

Cross-References

- Dental Hygiene for Children with Cerebral Palsy
- Drooling in the Child with CP – Medical Management
- Surgical Treatment for Drooling in the Child with CP

References

Abanto J, Carvalho TS, Bönecker M, Ortega AO, Ciamponi AL, Raggio DP (2012) Parental reports of the oral health-related quality of life of children with cerebral palsy. BMC Oral Health 12:15. https://doi.org/10.1186/1472-6831-12-15

Al-Allaq T, DeBord TK, Liu H, Wang Y, Messadi DV (2015) Oral health status of individuals with cerebral palsy at a nationally recognized rehabilitation center. Spec Care Dentist 35(1):15–21. https://doi.org/10.1111/scd.12071

Alhashmi H, Kowash M, Al Halabi M (2017) Medical and dental implications of cerebral palsy: part 2: oral and dental characteristics: a review. JSM Dent 5(2):1089

Botti Rodrigues Santos MT, Duarte Ferreira MC, de Oliveira GR, Guimarães AS, Lira Ortega A (2015) Teeth grinding, oral motor performance and maximal bite force in cerebral palsy children. Spec Care Dentist 35(4):170–174. https://doi.org/10.1111/scd.12106

Cardoso AM, Gomes LN, Silva CR, Soares Rde S, Abreu MH, Padilha WW, Cavalcanti AL (2014) Dental caries and periodontal disease in Brazilian children and adolescents with cerebral palsy. Int J Environ Res Public Health 12(1):335–353. https://doi.org/10.3390/ijerph120100335

Carneiro NCR, Monteiro LR, Pordeus IA, Borges-Oliveira AC (2017) Oral sucking habits among children with Down syndrome and cerebral palsy. Spec Care Dentist 37(4):176–180. https://doi.org/10.1111/scd.12231

Casamassimo PS, Seale NS, Ruehs K (2004) General dentists' perceptions of educational and treatment issues affecting access to care for children with special health care needs. J Dent Educ 68(1):23–28

Cramer JJ, Wright SA (1975) The bean bag chair and the pedodontic patient with cerebral palsy. Dent Hyg (Chic) 49(4):167–168

Damle SG, Bhavsar JP (1995) Plaque removing efficacy of individually modified toothbrushes in cerebral palsy children. ASDC J Dent Child 62(4):279–282

Das UM, Beena JP, Reddy D (2010) Importance of oral hygiene habits in mentally disabled children. Int J Clin Pediatr Dent 3(1):39–42. https://doi.org/10.5005/jp-journals-10005-1052

Diéguez-Pérez M, de Nova-García MJ, Mourelle-Martínez MR, Bartolomé-Villar B (2016) Oral health in children with physical (cerebral palsy) and intellectual (Down syndrome) disabilities: systematic review I. J Clin Exp Dent 8(3):e337–e343. https://doi.org/10.4317/jced.52922

dos Santos MT, de Oliveira LM (2004) Use of cryotherapy to enhance mouth opening in patients with cerebral palsy. Spec Care Dentist 24(4):232–234

dos Santos MT, Souza CB (2009) Traumatic dental injuries in individuals with cerebral palsy. Dent Traumatol 25 (3):290–294. https://doi.org/10.1111/j.1600-9657.2009.00765.x

dos Santos MT, Masiero D, Simionato MR (2002) Risk factors for dental caries in children with cerebral palsy. Spec Care Dentist 22(3):103–107

Dougherty NJ (2009) A review of cerebral palsy for the oral health professional. Dent Clin N Am 53(2):329–338. https://doi.org/10.1016/j.cden.2008.12.001

Du RY, McGrath C, Yiu CK, King NM (2010) Health- and oral health-related quality of life among preschool children with cerebral palsy. Qual Life Res 19(9):1367–1371. https://doi.org/10.1007/s11136-010-9693-6

Dubey A, Ghafoor PA, Rafeeq M (2015) Assessment of traumatic dental injuries in patients with cerebral palsy. J Indian Soc Pedod Prev Dent 33(1):25–27. https://doi.org/10.4103/0970-4388.148969

Escanilla-Casal A, Aznar-Gómez M, Viaño JM, López-Giménez A, Rivera-Baró A (2014) Dental treatment under general anesthesia in a group of patients with cerebral palsy and a group of healthy pediatric patients. Med Oral Patol Oral Cir Bucal 19(5):e490–e494. https://doi.org/10.4317/medoral.19568

Francis JR, Addy M, Hunter B (1987) A comparison of three delivery methods of chlorhexidine in handicapped children. II. Parent and house-parent preferences. J Periodontol 58(7):456–459

Gonçalves GK, Carmagnani FG, Corrêa MS, Duarte DA, Santos MT (2008) Dental erosion in cerebral palsy patients. J Dent Child (Chic) 75(2):117–120

Harris MM, Dignam PF (1980) A non-surgical method of reducing drooling in cerebral-palsied children. Dev Med Child Neurol 22(3):293–299

Hegde AM, Pani SC (2009) Drooling of saliva in children with cerebral palsy-etiology, prevalence, and relationship to salivary flow rate in an Indian population. Spec Care Dentist 29(4):163–168. https://doi.org/10.1111/j.1754-4505.2009.00085.x

Holan G, Peretz B, Efrat J, Shapira Y (2005) Traumatic injuries to the teeth in young individuals with cerebral palsy. Dent Traumatol 21(2):65–69

Inga CJ, Reddy AK, Richardson SA, Sanders B (2001) Appliance for chronic drooling in cerebral palsy patients. Pediatr Dent 23(3):241–242

Jaccarino J (2009) Treating the special needs patient with a developmental disability: cerebral palsy, autism and Down syndrome. Dent Assist 78(6):7–8, 10–11, 34 passim

Jan BM, Jan MM (2016) Dental health of children with cerebral palsy. Neurosciences (Riyadh) 21(4):314–318. https://doi.org/10.17712/nsj.2016.4.20150729

Jensen TM (2008) Evidence based dental care for children with cerebral palsy. https://pdfs.semanticscholar.org/8855/289d7a704c2b02f10630d4aada49d49e235d.pdf?_ga=2.262608009.449289782.1508710228-1408071844.1508710228. Accessed 22 Oct 2017

Johnson HM, Reid SM, Hazard CJ, Lucas JO, Desai M, Reddihough DS (2004) Effectiveness of the Innsbruck sensorimotor activator and regulator in improving saliva control in children with cerebral palsy. Dev Med Child Neurol 46(1):39–45. https://doi.org/10.1111/j.1469-8749.2004.tb00432.x

Jones MW, Morgan E, Shelton JE, Thorogood C (2007) Cerebral palsy: introduction and diagnosis (part 1). J Pediatr Health Care 21(3):146–152. https://doi.org/10.1016/j.pedhc.2006.06.007

Katz CR (2012) Integrated approach to outpatient dental treatment of a patient with cerebral palsy: a case report. Spec Care Dentist 32(5):210–217. https://doi.org/10.1111/j.1754-4505.2012.00267.x

Kaufman E, Kadari A, Galili D, Garfunkel A (1982) Nitrous oxide analgesia in selected dental patients. Anesth Prog 29(3):78–80

Kumar S, Sharma J, Duraiswamy P, Kulkarni S (2009) Determinants for oral hygiene and periodontal status among mentally disabled children and adolescents. J Indian Soc Pedod Prev Dent 27(3):151–157. https://doi.org/10.4103/0970-4388.57095

Levy H (2011a) Management of anxious and special-needs patients: there's always a way. Part 1. NJAGD Wisdom Mag 10(4):5–7. http://www.drhlevyassoc.com/clinicians/clinicians.htm. Accessed 20 Oct 2017

Levy H (2011b) Management of anxious and special-needs patients: there's always a way. Part 2. NJAGD Wisdom Mag 11(1):6–8. http://www.drhlevyassoc.com/clinicians/clinicians.htm. Accessed 20 Oct 2017

Levy H (2016a) Comprehensive general dentistry in the O.R. Part 1. J N Y State Acad Gen Dent Winter: 6–12. http://www.drhlevyassoc.com/clinicians/clinicians.htm. Accessed 20 Oct 2017

Levy H (2016b) Comprehensive general dentistry in the O.R. Part 2. J N Y State Acad Gen Dent Fall: 6–11. http://www.drhlevyassoc.com/clinicians/clinicians.htm. Accessed 20 Oct 2017

Levy H, Rotenberg LR (2016) Tools and equipment for managing special care patients anywhere. Dent Clin N Am 60(3):567–591. https://doi.org/10.1016/j.cden.2016.03.001

Loyola-Rodriguez JP, Aguilera-Morelos AA, Santos-Diaz MA, Zavala-Alonso V, Davila-Perez C, Olvera-Delgado H, Patiño-Marin N, De Leon-Cobian I (2004) Oral rehabilitation under dental general anesthesia, conscious sedation, and conventional techniques in patients affected by cerebral palsy. J Clin Pediatr Dent 28(4):279–284

Maeda T, Takei K, Seki M, Kawashima S, Akasaka M, Matsumoto M, Tanaka H, Kurihara Y (1990) The management of drooling in patients with cerebral palsy – submandibular duct relocation. Shoni Shikagaku Zasshi 28(3):676–684. Japanese

Maiya A, Shetty YR, Rai K, Padmanabhan V, Hegde AM (2015) Use of different oral hygiene strategies in children with cerebral palsy: a comparative study. J Int Soc Prev Community Dent 5(5):389–393. https://doi.org/10.4103/2231-0762.165925

Miamoto CB, Pereira LJ, Ramos-Jorge ML, Marques LS (2011a) Prevalence and predictive factors of sleep bruxism in children with and without cognitive impairment. Braz Oral Res 25(5):439–445

Miamoto CB, Ramos-Jorge ML, Ferreira MC, Oliveira MD, Vieira-Andrade RG, Marques LS (2011b) Dental trauma in individuals with severe cerebral palsy: prevalence and associated factors. Braz Oral Res 25

(4):319–323. https://doi.org/10.1590/S1806-83242011000400007

National Institute of Dental and Craniofacial Research (2014) Practical oral care for people with cerebral palsy. NIH Publication No. 09-5192. https://www.nidcr.nih.gov/OralHealth/Topics/DevelopmentalDisabilities/PracticalOralCarePeopleCerebralPalsy.htm. Accessed 18 Oct 2017

Neville L (2005) The fundamental principles of seating and positioning in children and young people with physical disabilities. http://www.leckey.com/pdfs/The_fundamental_principles_of_seating_and_positioning_in_children_and_young_people_with_physical_disabilities.pdf. Accessed 19 Oct 2017

Nielsen LA (1990) Caries among children with cerebral palsy: relation to CP-diagnosis, mental and motor handicap. ASDC J Dent Child 57(4):267–273

Oliveira CA, de Paula VA, Portela MB, Primo LS, Castro GF (2011) Bruxism control in a child with cerebral palsy. ISRN Dent 2011:146915. https://doi.org/10.5402/2011/146915

Ortega AO, Guimarães AS, Ciamponi AL, Marie SK (2007) Frequency of parafunctional oral habits in patients with cerebral palsy. J Oral Rehabil 34 (5):323–328

Ortega AO, Guimarães AS, Ciamponi AL, Marie SK (2008) Frequency of temporomandibular disorder signs in individuals with cerebral palsy. J Oral Rehabil 35(3):191–195. https://doi.org/10.1111/j.1365-2842.2007.01766.x

Patton LL, Glick M (eds) (2012) The ADA practical guide to patients with medical conditions. Wiley-Blackwell, Hoboken

Peres AC, Ribeiro MO, Juliano Y, César MF, Santos RC (2007) Occurrence of bruxism in a sample of Brazilian children with cerebral palsy. Spec Care Dentist 27 (2):73–76

Pope JE, Curzon ME (1991) The dental status of cerebral palsied children. Pediatr Dent 13(3):156–162

Roberto LL, Machado MG, Resende VL, Castilho LS, Abreu MH (2012) Factors associated with dental caries in the primary dentition of children with cerebral palsy. Braz Oral Res 26(5):471–477. https://doi.org/10.1590/S1806-83242012005000018

Rodrigues dos Santos MT, Bianccardi M, Celiberti P, de Oliveira GR (2009) Dental caries in cerebral palsied individuals and their caregivers' quality of life. Child Care Health Dev 35(4):475–481. https://doi.org/10.1111/j.1365-2214.2009.00976.x

Santos MT, Biancardi M, Guare RO, Jardim JR (2010a) Caries prevalence in patients with cerebral palsy and the burden of caring for them. Spec Care Dentist 30 (5):206–210. https://doi.org/10.1111/j.1754-4505.2010.00151.x

Santos MT, Manzano FS, Chamlian TR, Masiero D, Jardim JR (2010b) Effect of spastic cerebral palsy on jaw-closing muscles during clenching. Spec Care Dentist 30(4):163–167. https://doi.org/10.1111/j.1754-4505.2010.00143.x

Santos MT, Diniz MB, Gouw-Soares SC, Lopes-Martins RA, Frigo L, Baeder FM (2016) Evaluation of low-level laser therapy in the treatment of masticatory muscles spasticity in children with cerebral palsy. J Biomed Opt 21(2):28001. https://doi.org/10.1117/1.JBO.21.2.028001

Schultz ST, Shenkin JD, Horowitz AM (2001) Parental perceptions of unmet dental need and cost barriers to care for developmentally disabled children. Pediatr Dent 23(4):321–325

Sehrawat N, Marwaha M, Bansal K, Chopra R (2014) Cerebral palsy: a dental update. Int J Clin Pediatr Dent 7(2):109–118. https://doi.org/10.5005/jp-journals-10005-1247

Shaw L, Weatherill S, Smith A (1998) Tooth wear in children: an investigation of etiological factors in children with cerebral palsy and gastroesophageal reflux. ASDC J Dent Child 65(6):484–486, 439

Sinha N, Singh B, Chhabra KG, Patil S (2015) Comparison of oral health status between children with cerebral palsy and normal children in India: a case-control study. J Indian Soc Periodontol 19(1):78–82. https://doi.org/10.4103/0972-124X.145800

Soncini JA, Tsamtsouris A (1989) Individually modified toothbrushes and improvement of oral hygiene and gingival health in cerebral palsy children. J Pedod 13 (4):331–334

Souza VA, Abreu MH, Resende VL, Castilho LS (2015) Factors associated with bruxism in children with developmental disabilities. Braz Oral Res 29:1–5. https://doi.org/10.1590/1807-3107BOR-2015.vol29.0009

St. Renatus, LLC (2016a) KOVANAZE literature (tetracaine HCl and oxymetazoline HCl nasal spray). Reference ID: 3953045. https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208032s000lbl.pdf. Accessed 14 Jul 2016

St. Renatus, LLC (2016b) KOVANAZE website. www.Kovanaze.com. Accessed 19 Oct 2017

St. Renatus, LLC (2016c) Press release: St. Renatus, LLC announces FDA approval of KOVANAZE™ (tetracaine HCL and oxymetazoline HCl) nasal spray for use. http://st-renatus.com/st-renatus-llc-press-release/. Accessed 14 Jul 2016

Stoopler ET (2014) Oral health and the child with cerebral palsy. Medscape, Dec 26, 2014. www.medscape.com. Accessed 18 Aug 2017

Su JM, Tsamtsouris A, Laskou M (2003) Gastroesophageal reflux in children with cerebral palsy and its relationship to erosion of primary and permanent teeth. J Mass Dent Soc 52(2):20–24

Tahmassebi JF, Luther F (2004) Relationship between lip position and drooling in children with cerebral palsy. Eur J Paediatr Dent 5(3):151–156

US Food and Drug Administration (2016) FDA NDA approval letter: Kovanaze (NDA 208032). Reference ID: 3953045. https://www.accessdata.fda.gov/drugsatfda_docs/appletter/2016/208032Orig1s000ltr.pdf. Accessed 14 Jul 2016

Vujicic M, Yarbrough C, Nasseh K (2014) The effect of the Affordable Care Act's expanded coverage policy on access to dental care. *Med Care*. 52(8):715–19

Yoshida M, Nakajima I, Uchida A, Yamaguchi T, Akasaka M (2003) Effect of nitrous oxide on dental patients with cerebral palsy – using an electromyogram (EMG) from orofacial muscles as an index. J Oral Rehabil 30 (3):324–333

Zamzam N, Luther F (2001) Comparison of lip incompetence by remote video surveillance and clinical observation in children with and without cerebral palsy. Eur J Orthod 23(1):75–84