Review Article

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Dental treatment under general anesthesia for patients with severe disabilities

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Patients with disabilities have difficulties tolerating in-office dental treatment due to limitations relating to cooperation and/or physical problems. Therefore, they often require general anesthesia or sedation to facilitate safe treatment. When deciding on dental treatment under general anesthesia, the plan should be carefully determined because compared to general patients, patients with disabilities are more likely to experience anesthetic complications because of their underlying medical conditions and potential drug interactions. Clinicians prefer simpler and more aggressive dental treatment procedures, such as extraction, since patients with impairment have difficulty maintaining oral hygiene, resulting in a high incidence of recurrent caries or restorative failures. This study aimed to review the available literature and discuss what dentists and anesthesiologists should consider when providing dental treatment to patients with severe disability under general anesthesia.

Keywords: Dental Care for Disabled; General Anesthesia.

INTRODUCTION

Patients with mental or physical disabilities usually struggle to access dental services and have difficulties in tolerating treatment. Patients who lack cooperation and have physical or mental impairments often require sedation or general anesthesia to facilitate dental treatment [1,2]. Although sedation could be an effective and safe alternative to general anesthesia for patients with disability, sedation may be difficult in patients with severe cooperation problems, especially in terms of maintaining the airway [2,3]. For some patients with disability, any treatment process that requires them to sit still and keep their mouth open without any sudden movements is challenging [2-4]. Clinicians may prefer to perform comprehensive treatment for patients with severe impairment under general anesthesia for safety and efficacy, despite the potential risks associated with anesthesia [1]. A few studies have presented dental treatments for adult patients with severe disabilities requiring general anesthesia. This study aimed to review the available literature and discuss what dentists and anesthesiologists should consider when providing dental treatment to patients with severe disabilities under general anesthesia.

METHODS

The literature was searched using Medline, PubMed, and the Cochrane Library databases. The following terms

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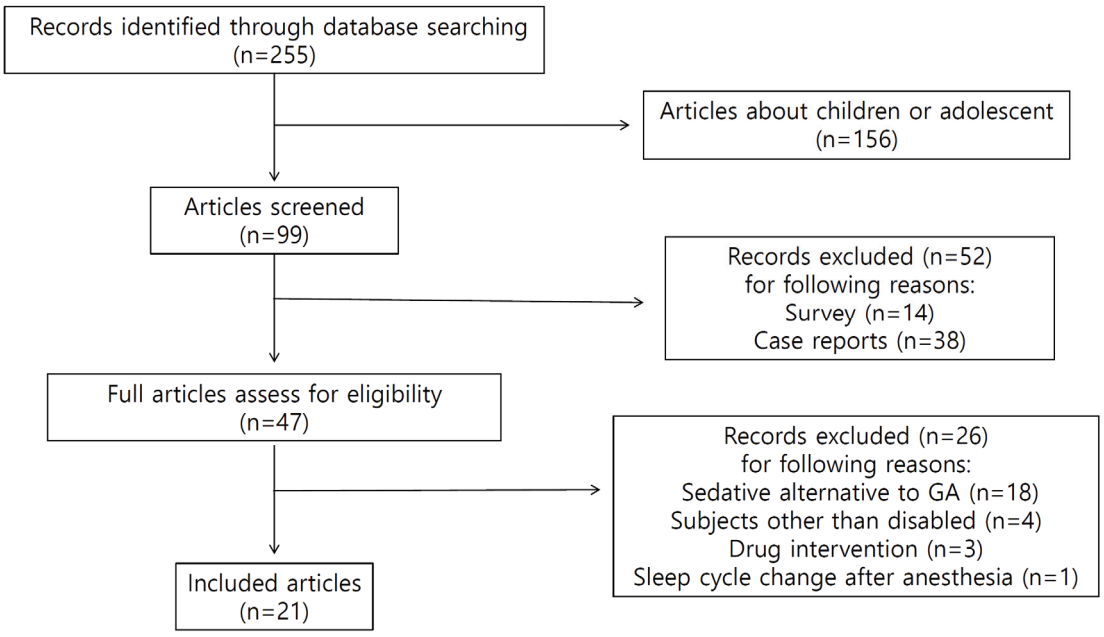

Fig. 1. Study selection flowchart. GA, general anesthesia.

were used for the search: disability, special needs, impairment, intellectual disability, autism, cerebral palsy, Down syndrome, general anesthesia, dental treatment, and dental care. Among the papers published from 2000 to 2021, only literature written in English was included. Articles about dental treatment under general anesthesia were selected and the subjects were limited to patients with severe disabilities requiring general anesthesia. In total, 255 articles were found. Of these, papers relating to children or adolescents and articles that were case reports or surveys were excluded. The full text of the remaining 47 articles was reviewed and unrelated articles were excluded. A total of 21 studies were finally included in the review. A detailed overview of the data selection process is presented in Fig. 1.

The articles included are listed in Table 1. Of the 21 studies, nine were about anesthetic considerations, and the rest were focused on dental care. Anesthetic considerations included indications and risks or complications of general anesthesia, and considerations during surgery. Dental contents were mainly about the prognosis of dental treatment in patients with disabilities, the comparison of oral hygiene with others, and the dental treatment procedures during general anesthesia.

CONSIDERATIONS OF GENERAL ANESTHESIA FOR DISABILITIES

1. Indications for general anesthesia

The indications for general anesthesia for dental treatment include medically compromised patients, patients with cooperation difficulties, and patients requiring extensive dental treatment [5] (Table 2). The most common indications for general anesthesia are lack of cooperation and multiple comorbidities [6-9]. Previous studies reported that approximately 45 % of patients required general anesthesia for their dental treatment due to cooperation difficulties related to autism, dementia, intellectual disability, and other mental disabilities [1,6,10]. Patients with autistic spectrum disorder (ASD) should be evaluated individually to determine whether local anesthesia, sedation, or general anesthesia are appropriate because cooperation varies from patient to patient. Depending on their level of learning difficulty and cooperation, repetitive learning may improve cooperation to enable treatment without general anesthesia [9,11]. Patients with ASD do not have a higher anesthetic risk than others, but more teeth might be

Table 1. Descriptions of included studies

Author (year)	Type of article	Description
Anesthetic Contents		
Boynes SG, et al. (2010) [47]		Identify and quantify complications occurring with the administration of anesthesia for the dental treatment of patients with special needs
Hanamoto H, et al. (2016) [23]	Retrospective study	Determine which method of premedication is more effective for these patients, 0.15 mg/kg of intramuscular midazolam or 0.3mg/kg of oral midazolam
Higuchi H, et al. (2018) [43]	Retrospective study	Investigate whether intellecual disability affects the time taken to emerge from general anesthesia
Hulland S, et al. (2000) [7]		Determine if any single or selected characteristics could be used as predictors in defining which individuals ought to be treated in a hospital based dental program
Lim SW, et al. (2018) [24]	Retrospective study	Investigate the effect of midazolam and triazolam premedication before general anesthesia in patients with difficulty in cooperation
Maeda S, et al. (2015) [41]	Retrospective study	Identify factors affecting emergence from general anesthesia, in which each antiepileptic drugs was included as a predictor variable
Ouchi K, et al. (2015) [28]		Investigate the impact of the type of neurological disorder on the required propofol dose for anesthesia and the time to emerge from anesthesia a during dental treatment
Vargas Roman Mdel P, et al. (2003) [5]	Review	Review of the most important aspects relating ti general anesthesia in dental therapy
Yumura J, et al. (2011) [48]		Investigate risk factors for postoperative nausea and vomiting after day care general anesthesia in mentally challenged patients undergoing dental treatment
Dental Contents		
Chang J, et al. (2014) [12]	Comparative study	Correlate the caries related variables of special needs patients to the incidence of new caries
Chang J, et al. (2014) [52]		Evaluated the caires risk profile of patients with severe intellectual disabilities who received dental treatment under general anesthesia
Chang J, et al. (2017) [58]	Observational study	Evaluate the longevity of teeth with single visit endodontic and restorative treatment under general anesthesia for special needs patients and to investigate factors associated with survive and success
Chung SH, et al. (2019) [62]		Determine the prognostic factors of periapical healing of teeth after single visit nonsurgical endodontic treatment under general anesthesia in speical needs patients
Ekfeldt A, et al. (2013) [69]	Prospective study	Study the medium to long term outcome of implant treatment in patients with neurologic disabilities
Fernandez-Feijoo J, et al. (2019) [37]	Retrospective study	Assess in patients with severe disability operated under general anesthesia whether the progressive acquisition of experience by the dental team affects the type of procedure performed and the duration of operations
Jockusch J, et al. (2020) [38]	Retrospective study	Highlight the need for dental treatment performed under general anesthesia for people with disabilities and the associated indications and treament patterns.
Jockusch J, et al. (2021) [54]		Analyse the treatment needs of patients who had received dental treatment under general anesthesia and the effectiveness of the treatment provided
Kim IH, et al. (2017) [65]	Retrospective study	Investigate outcomes following dental implantation in patients with special needs who required general anesthesia to enable treatment
Kovacic I, et al. (2012) [57]	Retrospective study	Determine the characteristics of comprehensive dental care in intellectual disability persons under general anesthesia, and to determine whether any changes have occurred in dental procedures during 25 years.
Maes MS, et al. (2021) [63]	Retrospective study	Assess the survival of direct composite resotrations placed under general anesthesia in adult patients with intellectual and/or physical disabilities
Schnabl D, et al. (2019) [53]	Retrospective study	Assessment of demand for restorative therapy and tooth extractions under general anesthesia in adults with intellectual and/or ohysical disablement or psychiatric disorders with inherent dentist phobia

extracted because of their more complex cooperation problem and poorer oral hygiene [12,13]. Therefore, it is necessary to individually determine if general anesthesia is required for patients with autism as the level of individual cooperation varies. Similarly, for patients with intellectual disability, general anesthesia is considered case-by-case based on the level of cooperation difficulties [14].

The other indication for undergoing general anesthesia is motor dysfunctions and uncontrolled tremors, such as patients with cerebral palsy, epilepsy, Parkinson's disease, or other brain diseases [6]. Cerebral palsy is one of the most common conditions for which dental treatment under general anesthesia is required because it is characterized by muscle paralysis, involuntary physical movements, poor coordination, muscle weakness, and

Table 2. Indications of general anesthesia undergoing dental treatments

Cooperative problems
Autism
Intellectual impairment
Dementia
Panic disorder
Motor dysfunction
Cerebral palsy
Epilepsy
Parkinson's disease
Other brain diseases
Skeletal muscle disorders
Craniofacial abnormalities
Down syndrome
Other genetic syndromes

Table 3. Parameters for preoperative evaluation

Anesthetic preoperative evaluation
Past medical history
Taking medication
Allergies
Previous anesthetic exposure
Blood test
Chest x-ray
EKG
Dental Preoperative assessment
Duration of operation
Type of treatment procedure
Number of appointments

EKG, electrocardiogram.

other motor dysfunctions [15]. Unlike patients with lack of cooperation, patients with cerebral palsy, who may be able to communicate and control their behaviors, have involuntary movements that can lead to emergencies during treatment. Since motor disorders vary, different methods of sedation, alone or in combination, may be used to facilitate dental treatment depending on the patient's physical condition, treatment needs, and duration of the operation [16]. Therefore, patients with brain lesions or skeletal disorders may be indicated for dental treatment under general anesthesia depending on their physical condition and the type of dental treatment required.

2. Preoperative evaluation

The American Society of Anesthesiologists (ASA) physical status classification is most commonly used as a guideline for pre-anesthesia assessment [17]. For patients classified as ASA 1 and 2, anesthesia can be safely performed [18]. However, for patients with disabilities, evaluation before anesthesia may be difficult. Although a basic preoperative evaluation using blood tests cannot be performed, blood tests are often performed under anesthesia [19,20]. Since thorough medical examinations are difficult, the patient's past medical history, previous anesthetic exposures, allergies, and drug use before the operation should be discussed with the parents/caregivers [20] (Table 3). In Haywood's study, most patients with disabilities who required general anesthesia were ASA grade I and II, but patients who were classified as ASA grade III and IV were 21% and 3%, respectively [20]. For patients classified as ASA 3 and 4, a medical consultation must be performed if dental treatment under general anesthesia is planned [6]. In addition, according to Wong's study, dental treatment under general anesthesia is not recommended for patients with ASA V [6] (Table 4).

3. Premedication

Premedication via oral benzodiazepines is commonly used. Premedication is often indicated for patients who are uncooperative to calm their anxious behaviors and facilitate anesthesia induction, such as wearing a facial mask for inhalation sedation or cannulation for intravenous sedation (Table 5) [10]. The use of benzodiazepines may affect intraoperative anesthetic requirements, postoperative complications, and behavior recovery, resulting in significantly longer recovery time and complicating the postoperative psychological and pain recovery processes [11,21,22].

A study on the effectiveness of different administrative routes of midazolam suggests that oral midazolam is more commonly recommended than intramuscular injection for patients with intellectual disability [23]. Furthermore, a study comparing the patients changing cooperative levels after receiving two different types of oral premedication, midazolam, and triazolam, concluded that the effects of

Table 4. The American Society of Anesthesiologists (ASA) Physical Status Classification System (Approved by the ASA House of Delegates on October 15, 2014, and last amended on December 13, 2020)

ASA PS classification	Definition	Adult examples
ASA 1	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use
ASA 2	A patient with a mild systemic disease	Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease
ASA 3	A patient with a severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI 40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, history (> 3 months) of MI, CVA, TIA, or CAD/stents
ASA 4	A patient with a severe systemic disease that is a constant threat to life	Recent (< 3 months) MI, CVA, TIA or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, shock, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis
ASA 5	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
ASA 6	A declared brain-dead patient whose organs are being removed for donor purposes	

ARD, acute renal disease; ASA, American Society of Anesthesiologists; BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; DIC, disseminated intravascular coagulation; ESRD, end-stage renal disease; HTN, hypertension; MI, myocardial infarction; TIA, transient ischemic attack.

the two drugs were not significantly different [24].

4. Intraoperative Management

There is no specific contraindication for the use of anesthetic agents, such as propofol and desflurane. In patients who are uncooperative or patients with physical impairments, venous access for the induction of anesthesia is the main challenge. In these cases, sevoflurane may be used to induce anesthesia safely and effectively [10,20,25]. Patients with ASD have a lower sensitivity to anesthesia, leading to a higher dose of propofol and delayed recovery time because of neurochemical alterations, including the serotonin system, excitatory glutamate, and inhibitory GABA systems [26,27].

The interaction between some medications and anesthetics affects the perioperative period. The propofol dose required for patients who use antiepileptic drugs is more than that in patients who are not taking medication [28]. Moreover, patients receiving monoamine oxidase inhibitors (MAO) or selective serotonin reuptake inhibitors (SSRIs) have a higher risk of hypo/hypertension and coma after general anesthesia [29].

The risk of anesthesia complications significantly increases in patients with Down syndrome compared to other patients because of their characteristic anatomical features [30,31]. These characteristic facial features include microbrachycephaly, flat nasal bridge, short neck, protruding and large tongue, large tonsils and adenoids, narrow subglottis, and prolapsed epiglottis. Nearly 50 % of patients with Down syndrome have upper respiratory obstruction. These characteristic craniofacial anomalies increase the prevalence of perioperative airway obstruction and post-intubation stridor [30,32]. Moreover, since nasal intubation is usually preferred for dental procedures, it is more difficult for patients with abnormal anatomical structures to secure the airway [20]. Congenital heart anomalies affect approximately 40 % – 50 % of patients with Down syndrome and this may increase the risk of anesthesia complications, such as bradycardia. The incidence of bradycardia in patients with Down syndrome is approximately 3.7 %, which is a significantly higher rate compared with approximately 0.36 % for those without Down syndrome [30,31,33]. Congenital heart diseases may also lead to other complications such as pulmonary hypertension.

Table 5. Anesthetic considerations

Preoperative period	Intraoperative period	Postoperative period
Use of premedication	Difficulty of airway maintenance	Airway maintenance
	Excessive secretion	Risk of aspiration (epistaxis, secretion, vomiting)
	Risk of aspiration	Delayed emerge time
	Endotracheal intubation	Emergence delirium
	Vital sign maintenance	Assessment of pain
	Hypotension	
	Bradycardia	
	Pulmonary hypertension	
	Duration of operation	
	Type of treatment	

Table 6. Prognosis of dental treatments in patients with disabilities

Author (year)	Description	No. of patients	No. of teeth	F/U period	Survival rate
Chang J, et al. (2017) [58]	Endodontic treatments	203	381	6-81 mths	92.5%
Chung SH, et al. (2019) [62]	Endodontic treatments	241	448	> 1 yrs	97.4%
Ekfeldt A, et al. (2013) [69]	Implant prosthetic treatments	27	88	10 yrs	85.8%
Kim IH, et al. (2017) [65]	Implant prosthetic treatments	19	73	15-116 mths	94.9%
Maes MS, et al. (2021) [63]	Restorative treatments	101	728	5 yrs	67.7%

For patients with cerebral palsy, airway management may also be difficult due to excessive secretions and the risk of aspiration during anesthesia as a result of gastroesophageal reflux which commonly occurs [34,35]. These patients also have a higher risk of hypoxia during unconsciousness [29]. Furthermore, approximately 30 % of patients with cerebral palsy also have epilepsy, which must also be considered before dental treatment under general anesthesia [35]. For patients with skeletal muscle problems, such as myasthenia gravis, respiratory management is required during and after anesthesia [18].

Since the operative time is affected by anesthesia complications, preoperative dental assessment is necessary to reduce the time of treatment [36,37]. However, evaluating the dental condition is difficult and challenging in patients with severe disability, even taking radiographic images is not easy. Often, clinicians examine the patient's oral condition, diagnose, and treatment plan at the time of general anesthesia. The duration of treatment is affected by the type of dental procedures required and not the medical conditions [37]. In Jockusch's study, the median duration of the first general anesthesia was 180 min and decreased, as the number of general anesthesia sessions was repeated [38]. In another study, the average operative time was approximately 115 min [10]. More aggressive treatment, such as extraction, tends to be performed but this depends on the level of cooperation difficulties [39,40]. The awakening time may be longer to obtain adequate hemostasis, and it is important to control perioperative bleeding for postoperative recovery (Table 5) [41].

At least two general anesthetics are required for prosthetic treatment, but no studies have reported on the limitation of the number of anesthetics or the recommended interval between anesthesia. Therefore, it is necessary to carefully determine the type and sequence of treatment procedures for comprehensive oral management and to closely communicate with anesthesiologists to reduce the number of general anesthesia and the potential complications.

5. Postoperative management

Antiepileptic drugs cause an extended emergence time from anesthesia [28,35,42]. Even during preoperative fasting, antiepileptics should be administered to reduce perioperative or postoperative seizures [6]. In Higuchi's study, the emergence time in patients with intellectual disability was significantly longer compared with patients

without intellectual disability. Moreover, a lower bi-spectral index was observed and a smaller amount of propofol and remifentanil was required [43]. This prolonged emergence time from anesthesia is correlated with cholinergic dysfunction in patients with mental impairment [43-45].

In addition, structural disorders of the central nervous system can cause drowsiness during the postoperative period. For example, patients with Parkinson's disease tend to experience postoperative confusion and hallucinations, as inhaled anesthesia affects the concentration of dopamine in the brain, increasing the extracellular concentration and releasing dopamine by inhibiting reuptake in the synapses [29,46].

Ambulatory anesthesia may delay emergency care if complications or side effects of anesthesia occur after returning home, since there is no opportunity to monitor the patient's postoperative conditions in the hospital. Therefore, it is important to meticulously monitor the patient during recovery. In particular, patients with disabilities usually have a longer emergence time and greater difficulties in maintaining the airway due to their medical conditions and medications.

6. Complications

Boynes asserted that the prevalence of complications is not significantly different among different types of anesthesia and that complications occur in approximately 20 % to 30 % [47]. The risk of anesthetic complications is dependent on the patient's ASA classification, medical condition, type of anesthetic administration, and type of surgical procedures [47]. The complications may be mild. Approximately 4.2 % of cases are associated with moderate complications such as hypotension. Airway obstruction is the most common complication, followed by nausea and vomiting [34,47]. In Yumura's study, the incidence of postoperative nausea and vomiting in patients with intellectual disability was 5.6%, which is higher than that in the general population [48].

Some reports have suggested that more complications occur in patients with disabilities. Lim claimed that 44.4 % of patients with cerebral palsy have complications due to difficult airway management. Complications occurred in 30.4 % of patients with ASD, 29.2% of patients with Down syndrome, and 17.1% with intellectual disability [17]. Despite these complications, general anesthesia for patients with disabilities can be performed safely and successfully [49].

CONSIDERATION OF DENTAL TREATMENT UNDER GENERAL ANESTHESIA

1. Types of dental treatment

Patients with special needs have a higher prevalence of oral diseases, especially dental caries, and it is much more difficult to maintain their oral hygiene compared with other patients [1,34,50-52]. Some studies have reported that oral hygiene is poorer in patients with psychiatric disorders than in adults with intellectual and/or physical impairments [53,54]. The reason may be related to poorer oral hygiene in the more uncooperative patients [12]. As there is a higher risk of restorative failure, dentists tend to select more aggressive treatment [55]. Clinicians may also prefer to manage the patient with less complicated procedures to prevent treatment complications or failure [1,56].

The most common dental treatment procedure carried out in general anesthesia is extraction, rather than more time-consuming or complicated treatment options such as root cannal treatments [37,38,56]. In Jockush's study, root canal treatment was performed in only 2.2% of teeth [38]. Recently, the number of extractions has reduced, as dentists prefer to undertake more operative treatment [37,57].

2. Endodontic treatment

Endodontic treatment is often performed on a single day to reduce the number of ambulatory general anesthesia. In Chang's study, at the end of the observation period, 92.5% of single-visit endodontically treated teeth survived [58]. Although it is still difficult to determine

the treatment outcome of teeth with apical lesions requiring endodontic intervention. Previous studies have reported that the outcome of a single-visit endodontic treatment is not significantly different from the outcome of a multiple-visit endodontic treatment [59-61]. In Chung's study, 81.5 % of endodontically treated teeth with periapical lesions healed completely, while only 2.6 % of the teeth showed no reduction in the size of the lesions [62] (Table 6).

3. Restorative and prosthetic treatment

Meas reported that 32.3% of restorations require extraction or replacement during the 5-year follow-up [63] (Table 6). This is a higher failure rate than the general population. However, it is still an acceptable and favorable longevity. To choose prosthetic treatment, it is necessary to consider several factors, such as material strength, the degree of wear of the opposing tooth structures, and a proper appliance design to prevent recurrent caries and facilitate cleansing [64]. Due to good marginal fitness, less wear of the opposing tooth structure, sufficient material strength, and minimal tooth structure, gold is the most predictable material for patients with disabilities [64].

Since more teeth are removed, removable or implant-supported prosthetic treatment may be inevitable for patients with impairments. Because appliances are challenging to adapt and manage, a removable prosthesis is more difficult than a fixed prosthesis. However, have been hesitant to providing implants to patients with disabilities. The O'Leary plaque index for patients with intellectual disabilities is reported to be 60 % to 100 %, indicating that implants are contraindicated in most cases [65]. However, previous studies have reported that there is no significant difference in the success rate of implants between patients with impairment and the general population [66-69]. In Ekfeldt's study, the survival rate was 85.8 %, which is lower than that in the general population but still an acceptable outcome [70] (Table 6). This study observed that only 14% of implants were lost even though the patients had neurologic disabilities with difficulty in maintaining their oral hygiene. Since the medical condition is not a contraindication to implants, the ability to maintain oral hygiene, rather than the underlying medical condition, determines the type of dental treatment.

4. Maintenance

Many studies have suggested that follow-up reviews for patients with disabilities are essential but research on the ideal frequency or interval of follow-up is rare [1,4]. Maurer reported that the caries prevalence is slightly significantly increased in patients with treatment intervals of more than 12 months compared to those of shorter intervals [71]. In contrast, Jockusch reported that the failures and emergencies of treated teeth were low with a 12-month follow-up interval [54]. Other authors have suggested that patients need to be followed up every 2-6 months during the postoperative period to maintain oral hygiene [72,73].

Oral health and diet education for caregivers/parents of patients with disabilities are as important as follow-up reviews. The proper use of oral hygiene instruments such as electronic toothbrushes and bite blocks can help to improve oral hygiene [64]. It is necessary to educate caregivers/parents to limit the cariogenic food and drinks that increase the risk of dental caries. Screening programs or early intervention programs for oral diseases provided by community dental clinics may improve oral hygiene, reduce the need for aggressive treatment, and increase the preservation of teeth for patients with disabilities [56,57].

CONCLUSION

General anesthesia is preferred in patients with severe disabilities who have difficulty coping with dental treatment in the dental practice. Anesthetic complications are more likely to occur because of the patient's underlying medical conditions. Careful monitoring during the pre-, intra-, and post-operative periods is necessary

to minimize issues. Dentists should carefully plan and provide the necessary dental treatment, because the outcome of dental treatment in patients with disabilities is not always favorable. Therefore, to obtain a favorable prognosis, dentists and anesthesiologists should thoroughly evaluate each case before surgery and closely communicate during the intra- and post-operative periods.

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