Original Article

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# Dental treatments under sedation-analgesia in patients who are unable to collaborate: a prospective observational study

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**Background:** Excessive fear of dental procedures leads to disruptive behavior during dental examinations and treatments. Dental examinations and treatments of these patients usually require additional techniques, such as sedation. The most commonly used techniques are inhalation of nitrous oxide, infusion of propofol with fentanyl, and premedication and infusion of midazolam.
**Methods:** A prospective observational epidemiological study was conducted on patients who required sedoanalgesia techniques for dental exploration and procedures. The reasons for the inability of patients to cooperate (excessive fear or intellectual disability), age, sex, weight, systemic pathology, oral pathology, treatment performed, time of intervention, anesthetic technique performed, and occurrence of complications were recorded.
**Results:** In total, 218 patients were studied. Sixty-five patients came for fear of dental treatment and 153 for presenting with a diagnosis of intellectual disability and not collaborating in the treatment with local anesthesia. The average age of all patients was 30.54 ± 17.30 years. The most frequent oral pathologies found in patients with excessive fear were tartar (6.8%) and wisdom teeth (6.4%), followed by missing teeth (5%). In patients with disabilities, a combination of tartar and cavities appeared most frequently (41.3%), followed by cavities (15.6%). The most frequently used sedoanalgesia technique was the infusion of propofol with fentanyl in both groups of patients, followed by nitrous oxide.
**Conclusion:** The combination of propofol and fentanyl was the most frequently used alternative in patients who were unable to collaborate because of intellectual disability or carry out longer or more complex treatments. Inhaled nitrous oxide and midazolam were the sedative techniques of choice for simpler oral treatments, such as tartrectomies, shallow obturations, and shorter interventions, or in younger patients.

**Keywords:** Dental Treatment; Disabled Persons; General Anesthesia; Sedation.



## INTRODUCTION

There are situations in which patients cannot undergo dental treatment under local anesthesia, such as excessive fear and psychomotor or intellectual disability.

Excessive fear of dental procedures leads to disruptive behavior during dental examinations and treatments [1]. These behaviors range from physical rejection to refusal to undergo treatment. Despite the difficulty in determining its prevalence, it is estimated that 15% of the adult population experience excessive fear [2,3]. In

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young people, the prevalence ranges from 5–20% [4–6]. The behaviors derived from this fear in young patients have more abrupt clinical manifestations and worse consequences for long-term oral health [7,8], in addition to other problems in terms of quality of life and social avoidance [9,10].

According to the American Association of Intellectual and Developmental Disabilities, an individual with intellectual disability is a person with an intelligence quotent below 70 to 75, significant limitations in two or more adaptive areas (skills needed to live, work, and play in the community, such as communication or self-care), and the condition manifests itself before the age of 18 years. People with intellectual disabilities represent a large group with a worldwide prevalence of 1–4% [11]. When associated with psychomotor delay, the prevalence can reach up to 10%. The diagnosis and treatment of dental pathology in these individuals is difficult because of their inability to collaborate due to anxiety and fear [12].

Dental examination and treatment of these patients usually require additional techniques, such as sedation. The most commonly used techniques are inhalation of nitrous oxide, infusion of propofol with fentanyl, and premedication and infusion of midazolam.

Nitrous oxide, used as an inhalation sedative, is a central nervous system depressant gas that is administered at a concentration of 30–50% in combination with oxygen. Its absorption occurs through the lungs and its effects begin to be perceived after 2–5 min. Its analgesic effects at low doses and a certain amnesiac effect have been confirmed.

Propofol is a lipophilic alkylphenol that is used for intravenous sedation. It has a quick onset of action of approximately 40 s. The distribution half-life is 2-4 min and the elimination half-life is approximately 30–60 min [13,14]. Recovery from sedation after stopping the infusion occurs within approximately 10–15 min [15]. They are not significantly affected by alterations in liver or kidney function. The most common complications are arterial hypotension due to vasodilation, cardiovascular and respiratory depression, and apnea. These effects are directly related to the dose and speed of administration and the age and clinical status of the patient.

To meet analgesic needs, fentanyl, an opioid analgesic, is used. Its maximum effect is achieved within 7–15 min and its effect disappears between 1 and 2 h [13]. It is a safe drug even in cases of kidney failure. It is a major respiratory depressant; therefore, close monitoring is required when used as an analgesic in non-ventilated patients. Fentanyl does not produce relevant hemodynamic alterations; therefore, it is safe to use in patients with coronary diseases.

Midazolam is a benzodiazepine widely used for sedation owing to its sedative, hypnosis, anxiety control, musculoskeletal relaxation, anterograde amnesia, anticonvulsant, gag reflex reduction, and salivary flow properties [13]. When administered intravenously, the action begins after two min and its maximum effects are observed after 5–10 min. This effect disappeares after approximately 15–30 min. When sedation is interrupted, the accumulated drug must return to the circulation for metabolism, which is why its effects can be prolonged for hours or days in patients with obesity, older adults, and patients with kidney, liver, or heart failure [16,17]. The effects on the cardiovascular and respiratory systems are minimal, and there is a slight decrease in the blood pressure and heart and respiratory rates [18]. Its effects are enhanced in combination with other central nervous system depressants such as fentanyl and remifentanil.

Existing literature on the dental management of patients who are unable to collaborate under local anesthesia is scarce, and few studies discriminate between their therapeutic needs based on the reason for their lack of collaboration. It is necessary to conduct studies that describe procedures for individualized treatment to improve action and prevention protocols for improving oral health.

The main objective of this study was to compare sociodemographic differences, the need for dental treatment, and sedative-analgesic techniques used between patients with fear of dental treatment and those

diagnosed with disabilities who do not allow treatment under local anesthesia.

As a secondary objective, recommendations are proposed for management based on the analyzed characteristics.

## METHODS

A prospective observational epidemiological study was conducted in patients who required sedoanalgesia techniques for dental exploration and procedures. Clinical Trial EU Registration Number 2024-513323-16-00.

Ethical approval for this study (Ethical Committee N° 20/148-E) was provided by the Ethical Committee of the Hospital Clínico San Carlos, Madrid, Spain. This study was performed according to the guidelines of the Declaration of Helsinki (World Medical Assembly).

The data collected in this study were confidential and subject to data protection laws. Each patient was assigned a history number so that all researchers were unaware of the identity of the study subjects, as well as the relationship between their personal data and those corresponding to their clinical history.

Oral examination, diagnosis, and treatment were performed by a multidisciplinary team of professionals from the Department of Clinical Specialties of the Faculty of Dentistry at the Complutense University of Madrid. The indications for and performance of the sedative-analgesic procedure were determined by the same professionals from the Department of Pharmacology and Toxicology. The sedoanalgesic techniques included inhalation of nitrous oxide, infusion of propofol and fentanyl, premedication, and subsequent perfusion with midazolam. The anesthetist's criteria for selecting the type of sedation were based on the patient's ability to have minimal collaboration, age, and an estimate of the duration and complexity of the treatments based on clinical information.

The dose of each drug used for sedation was adjusted according to patient age, weight, pathology, and intervention time.

Nitrous oxide inhalation was performed slowly and progressively until a maximum concentration of 40% was reached. Propofol was slowly administered at an induction dose of 1 and 2.5 mg/kg. The maximum administered dose was 4.5 mg/kg/h. In all cases, fentanyl was administered as an adjuvant opioid. Fentanyl was administered via a slow infusion at a single dose of 1.5–2 mcg/kg. Midazolam was used at a maximum initial dose of 5 mg and a subsequent continuous infusion of 0.2–0.5 mg/kg [19]. If required, a maximum dose of 1 mg was administered as a sedative in combination with another drug. During treatment, patients were monitored using a pulse oximeter. Only the presence of alterations was recorded, considering such alterations in normal blood pressure (80–120 mm Hg), heart rate (60–100 beats per minute), and SpO2 (> 90%).

The inclusion criteria were as follows: patients between 6 and 99 years of age, who were treated at the Faculty of Dentistry of the Complutense University of Madrid and required the use of sedoanalgesia techniques during 2015–2019.

The reasons for the inability of patients to cooperate (excessive fear or intellectual disability), age, sex, weight, systemic pathology, oral pathology, treatment performed, time of intervention, anesthetic technique performed, and occurence of complications were recorded.

To avoid sample duplication, special attention was paid to patients who had previously undergone surgery for oral pathology. Cases in which the required information could not be obtained were excluded.

To facilitate statistical analysis, given the diversity of existing systemic pathologies, patients were grouped according to the International Classification of Diseases-11 WHO 2018 into mental, behavioral, and neurodevelopmental disorders; disorders of the nervous system; diseases of the circulatory system and blood; diseases of the nervous and musculoskeletal systems; endocrinopathies; digestive and urinary system disorders; and respiratory disorders [20].

Statistical analysis was performed by transcribing the

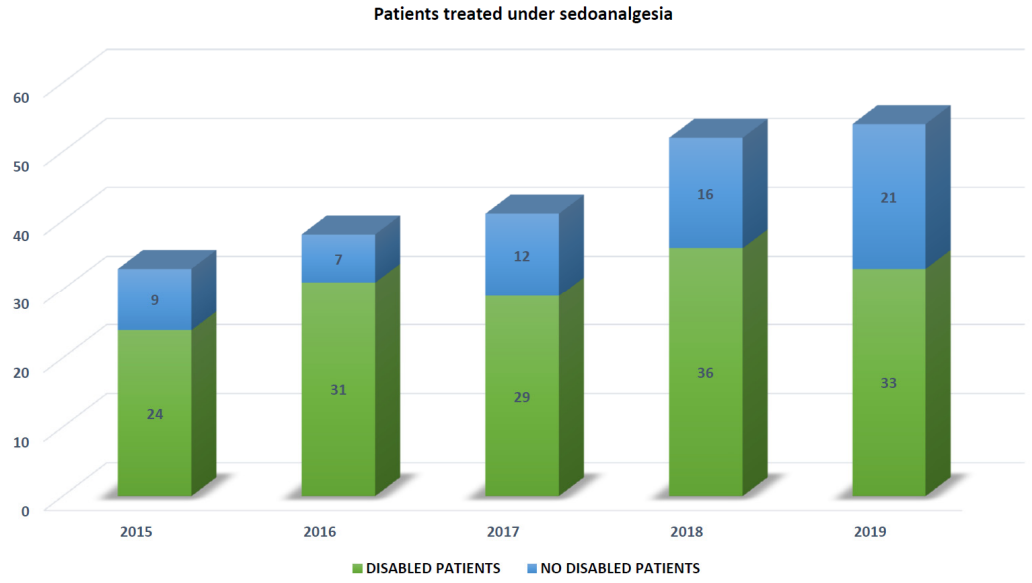


Fig. 1. Annual distribution of the frequency of patients operated on in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019.

Table 1. Distribution based on age of patients operated on in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019

| Age | Frequency (n) | | | Percentage (%) | | |
|---|---|---|---|---|---|---|
| | Intellectual disability | Excessive fear | Total | Intellectual disability | Excessive fear | Total |
| < 18 | 62 | 20 | 82 | 28.4% | 9.2% | 37.6% |
| 18-49 | 69 | 22 | 91 | 31.7% | 10.1% | 41.8% |
| > 49 | 22 | 23 | 45 | 10.1% | 10.5% | 20.6% |
| TOTAL | 153 | 65 | 218 | 70.2% | 29.8% | 100% |

n, number.

data from the recording sheets to the Microsoft Excel 2019® database. Statistical analysis was performed using Statistical Package for the Social Sciences for Windows (version 25.0)).

Descriptive analysis of the recorded data was performed. Subsequently, contingency tables were applied to determine the relationship between qualitative variables (oral pathology, general pathology, oral treatment, type of anesthesia, and complications), and the chi-square test was used to compare the influence of these variables, reporting the percentage and corrected residuals to uncover significant influences (> ± 1.96).

For continuous variables (age, weight, and intervention time), a bivariate relationship (CORR procedure) was used to obtain the Pearson correlation coefficient. A significant positive relationship was considered when the value was > 0.01.

## RESULTS

Patient care increased from 33 patients in 2015 to 54 in 2019. (Fig. 1).

A total of 218 patients treated in the Department of Pharmacology and Toxicology of the Faculty of Dentistry at the Complutense University of Madrid were studied. Of the total patients treated, 65 (26 women, 39 men) came for fear of dental treatment and 153 (77 women, 76 men) for presenting a diagnosis of intellectual disability and not collaborating in the treatment with local anesthesia.

The average age of all patients was 30.54 ± 17.30 years, with the youngest patient being 10 years old and the oldest patient being 72 years old.

To assess the frequency of care, patients were divided into into three groups based on age: 6–17, 18–49, and

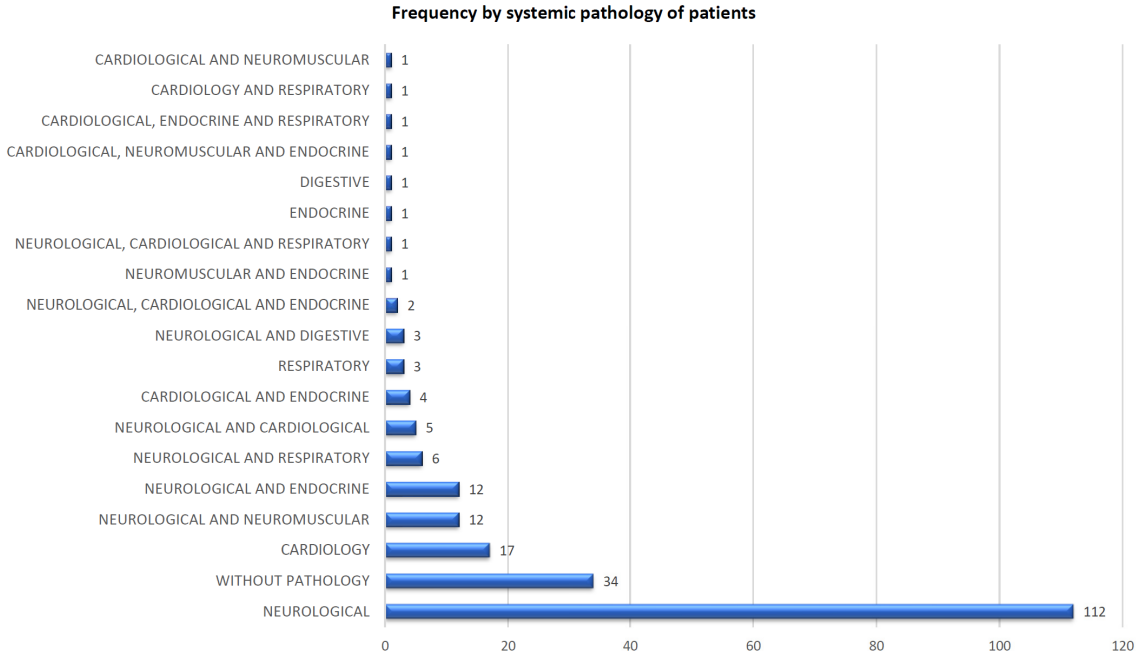


Fig. 2. Distribution in descending order of frequency of the systemic pathology of the patients operated on in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019.

Table 2. Frequency of oral pathology in patients operated on in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019

| Oral pathology | Patients frequency (n) | | | Percentage (%) | | |
|---|---|---|---|---|---|---|
| | Intellectual disability | Excessive fear | Total | Intellectual disability | Excessive fear | Total |
| Dental calculus and cavities | 90 | 0 | 90 | 41.3% | 0.0% | 41.3 |
| Cavities | 34 | 3 | 37 | 15.6% | 1.4% | 17.0 |
| Dental calculus | 1 | 15 | 16 | 0.5% | 6.8% | 7.3 |
| Caries and root remains | 15 | 0 | 15 | 6.9% | 0.0% | 6.9 |
| Wisdom pathology | 0 | 14 | 14 | 0.0% | 6.4% | 6.4 |
| Tooth absences | 0 | 11 | 11 | 0.0% | 5.0% | 5.0 |
| Root remains | 6 | 4 | 10 | 2.8% | 1.8% | 4.6 |
| Bone atrophy | 0 | 9 | 9 | 0.0% | 4.1% | 4.1 |
| Periodontal disease | 0 | 6 | 6 | 0.0% | 2.8% | 2.8 |
| Caries and tooth absence | 3 | 0 | 3 | 1.4% | 0.0% | 1.4 |
| Maxillary cavities and cyst | 3 | 0 | 3 | 1.4% | 0.0% | 1.4 |
| Canine retention | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Dental calculus, cavities and root remains | 1 | 0 | 1 | 0.5% | 0.0% | 0.5 |
| Maxillary cyst | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Supernumerary tooth retention | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Total | 153 | 65 | 218 | 70.2% | 29.8% | 100% |

n, number.

> 49 years (Table 1).

The group with excessive fear had a similar number of patients in the three age groups: under 18 years (9.2%), between 18 and 49 years (10.1%), and over 49 years (10.5%). There were more patients with disabilities in the age groups below 18 years (28.4 %) and between 18 and 49 years (31.7%).

The entire sample included 34 patients without diagnosed pathologies (15.6%) and 184 with systemic pathologies (84.4%) (Fig. 2). The largest group (51.4%) comprised patients grouped under the name of neurological diseases, including disorders such as anxiety,

Table 3. Frequency of oral treatments of patients operated on in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019. *Only non-surgical oral treatments are shown shaded

| Oral treatments | Patients frequency (n) | | | Percentage (%) | | |
|---|---|---|---|---|---|---|
| | Intellectual disability | Excessive fear | Total | Intellectual disability | Excessive fear | Total |
| Tartectomy and obturations* | 90 | 0 | 90 | 41.3% | 0.0% | 41.3 |
| Obturations * | 34 | 3 | 37 | 15.6% | 1.4% | 17.0 |
| Tartrectomy* | 15 | 1 | 16 | 0.5% | 6.8% | 7.3 |
| Obturations and extraction of root remains | 15 | 0 | 15 | 6.9% | 0.0% | 6.9 |
| Wisdom teeth extraction | 0 | 14 | 14 | 0.0% | 6.4% | 6.4 |
| Implant placement | 0 | 11 | 11 | 0.0% | 5.0% | 5.0 |
| Root remains extraction | 6 | 4 | 10 | 2.8% | 1.8% | 4.6 |
| Periodontal treatment* | 0 | 6 | 6 | 0.0% | 2.8% | 2.8 |
| Sinus lift | 0 | 5 | 5 | 0.0% | 2.3% | 2.3 |
| Bone grafts | 0 | 4 | 4 | 0.0% | 1.8% | 1.8 |
| Tartrectomy and prosthesis* | 3 | 0 | 3 | 1.4% | 0.0% | 1.4 |
| Tartrectomy and cystectomy | 3 | 0 | 3 | 1.4% | 0.0% | 1.4 |
| Canine surgical exposure | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Tartrectomy, obturations and root remains extraction | 1 | 0 | 1 | 0.5% | 0.0% | 0.5 |
| Cystectomy | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Supernumerary tooth extraction | 0 | 1 | 1 | 0.0% | 0.5% | 0.5 |
| Total | 153 | 65 | 218 | 70.2% | 29.8% | 100% |

n, number.

Table 4. The type of sedation used to perform dental treatments on patients (with and without disabilities) treated in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019

| | Nitrous oxide | Propofol-fentanyl | Midazolam |
|---|---|---|---|
| Disabled patients | 60 (39.2%) | 93 (60.8%) | 33 (21.6%) |
| No diabled patients | 29 (44.6%) | 36 (55.4%) | 8 (12.3%) |

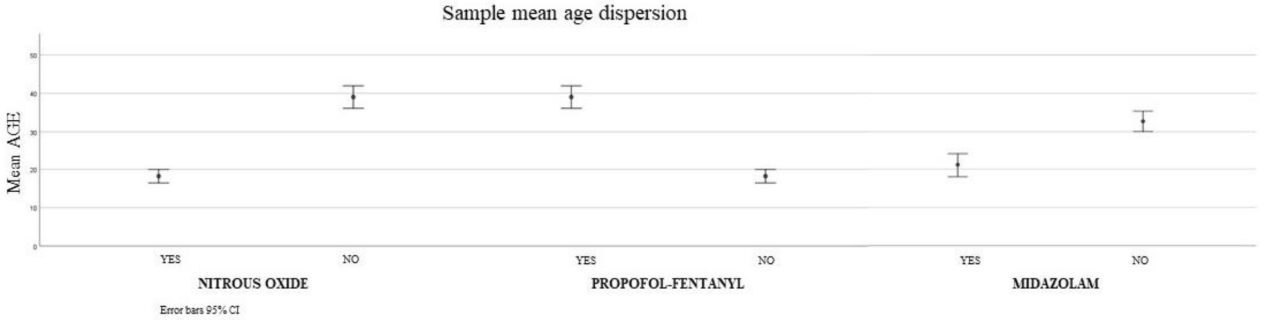


Fig. 3. Average age recorded in the sedation techniques used in patients treated in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019.

Down syndrome, and epilepsy. Patients with cardiac (7.8%), neurological and neuromuscular (5.5%), and endocrine disorders (5.5%) stood out in frequency.

The most frequent oral pathologies found in patients with excessive fear were tartar (6.8%) and wisdom teeth (6.4%), followed by missing teeth (5%). In patients with disabilities, the combination of tartar and cavities was most frequent (41.3%), followed by cavities (15.6%) (Table 2).

Given the diagnosis of oral pathology, non-surgical treatments (tartrectomies, fillings, periodontal treatments, and prostheses) (69.8%, n = 152) were performed more

Table 5. Dental pathologies treated under the sedation techniques used in patients of the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019

| | Nitrous oxide | Propofol-fentanyl | Midazolam |
|---|---|---|---|
| Dental calculus | 15 | 1 | 0 |
| Caries | 3 | 34 | 3 |
| Root remains | 0 | 10 | 0 |
| Wisdom pathology | 5 | 9 | 5 |
| Periodontal pathology | 6 | 0 | 0 |
| Tooth absecnce | 0 | 11 | 0 |
| Bone atrophy | 0 | 9 | 0 |
| Canine retention | 0 | 1 | 0 |
| Supernumerary tooth retention | 0 | 1 | 0 |
| Maxillary cyst | 0 | 1 | 0 |
| Dental calculus and cavities | 60 | 30 | 33 |
| Dental calculus, cavities and root remain | 0 | 1 | 0 |
| Cavities and maxillary cyst | 0 | 3 | 0 |
| Cavities and root remain | 0 | 15 | 0 |
| Cavities and tooth absence | 0 | 3 | 0 |
| Total | 89 | 129 | 41 |

Table 6. Correlations between age, weight, and intervention time for all sedation techniques used in patients of the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019

| | | Age | Weight | Intervention time |
|---|---|---|---|---|
| Age | Pearson correlation | 1 | 0.539** | 0.568** |
| | Sig. (2-tailed) | | 0.000 | 0.000 |
| | N | 218 | 218 | 218 |
| Weight | Pearson correlation | 0.539** | 1 | 0.490** |
| | Sig. (2-tailed) | 0.000 | | 0,000 |
| | N | 218 | 218 | 218 |
| Intervention time | Pearson correlation | 0.568** | 0.490** | 1 |
| | Sig. (2-tailed) | 0.000 | 0.000 | |
| | N | 218 | 218 | 218 |

**. Correlation is significant at the 0.01 level (2-tailed). N, number.

frequently than surgical treatments (tooth extractions of root remains, wisdom teeth or supernumerary teeth, sinus elevation, bone grafts, cystectomy, and surgical exposure for orthodontic traction) (30.4%, n = 66) (Table 3).

The most frequently used sedoanalgesics were propofol and fentanyl, followed by nitrous oxide, in both group of patients (Table 4).

Nitrous oxide was used in younger patients (18.20 ± 8.39 years). In older patients (39.05 ± 16.74 years), propofol and fentanyl were used more frequently (Fig. 3).

The combination of propofol and fentanyl was used more frequently to treat pathologies that required a longer intervention time and could be more traumatic owing to their nature (Table 5).

A statistically significant relationship was found between older patient age, higher weight, and longer duration owing to the complexity of the intervention performed (Table 6).

Eleven complications were recorded during sedation. The majority were respiratory depressions (mean age: 35.25 ± 16.73 years), which were reversed by reducing the amount of drug administered. Additionally, seizures during nitrous oxide inhalation were recorded in a 29-year-old patient who was successfully treated by decreasing nitrous oxide flow to 30% (Fig. 4).

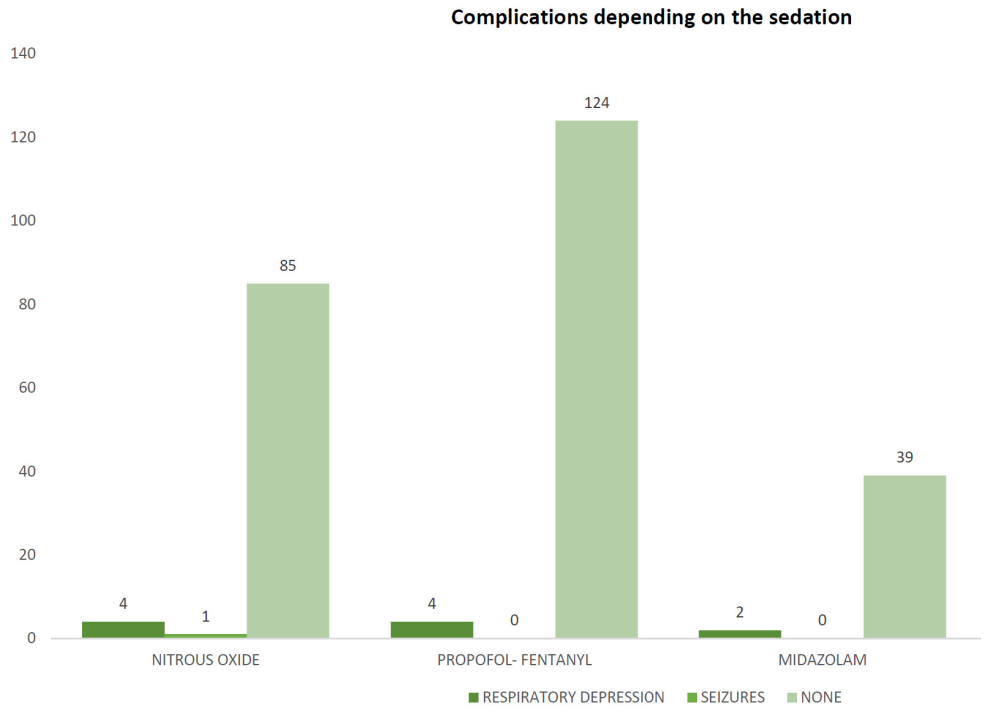


Fig. 4. Complications recorded under the sedation techniques used in patients treated in the Department of Pharmacology and Toxicology of the Faculty of Dentistry of the UCM from 2015 to 2019.

## DISCUSSION

Dental care has undergone significant development in recent years, and the alternatives available for the management of dental patients have expanded. However, few studies have analyzed the cause of the inability to collaborate, as well as alternatives for the management of these patients, depending on the dental procedure. Many authors do not consider the specific characteristics of individuals who are unable to collaborate, such as age or oral pathology. This makes it difficult to compare groups of studies to identify the specific needs of each patient group.

Each person's fear of dental treatment determines their control over hygiene, ability to collaborate, awareness of their health, and the medical complications that they may present [11,21-23]. Furthermore, the emotional state caused by fear of dental treatment is accompanied by a neuroendocrine response with hemodynamic alterations and metabolic effects, which have been related to a reduction in pain tolerance, an increase in the possibility that non-painful stimuli are interpreted as painful, and the appearance of cardiac alterations such as tachycardia, fluctuations in blood pressure, or vasovagal responses [24-26].

Sedoanalgesia can also be used for medically compromised patients [27,28]. It reduces anxiety and fear levels, produces mild analgesia, and reduces nausea and salivary flow in a manner that favors dental treatment [28–31].

In this study, a sample of 218 patients treated for five years was recorded, distinguishing 153 people with disabilities and 65 with excessive fear. The highest percentage of the population served corresponded to those with some type of disability in the age groups of < 18 years (28.4%) and between 18 and 49 years (31.7%). The sample size of this study is superior to that of previous studies, such as the 40 participants in the study by Picciani et al. [28]. Furthermore, unlike other studies that grouped all patients with intellectual disabilities, we grouped the different pathologies of patients [32]. The

5-year study period was similar to that reported by other authors, ranging from 2 to 5 years [32].

According to existing records based on a survey of disabilities, deficiencies, and health status, there are 3.8 million people with intellectual disabilities in Spain. This figure represents a 10% increase compared with that registered in 1999 [22].

In the literature, the classification of different pathologies, as well as intellectual disabilities, is not used in a unified manner. In the present study, patients were grouped according to the International Classification of Diseases-11 WHO 2018. Individuals neurological diseases had the highest frequency, because this group included frequent disorders such as anxiety, unknown intellectual disability, epilepsy, and autism.

Regarding division by sex, we found a slight predominance of men (115) compared to women (103), as in most studies [33–37]. The predominance of men in our study was due to the greater number of men with odontophobia. Only Othawa et al. [38] reported a significant difference, presenting almost twice as many men as women.

The highest frequency in patients with intellectual disabilities corresponded to the group of 18–49 years (31.7%), which was similar to that in patients below 18 years of age (28.4%). The difference with the > 50 years old group was justified by the possibility that our center offers conservative dental treatments compared to the benefits of the National Health System. In patients with odontophobia, age distribution was more balanced.

There is a high demand for oral treatment in this population because of the difficulty in providing dental care and maintaining adequate oral hygiene [33,34,39]. Dental treatment in these patients is usually aimed at performing the most predictable and least traumatic interventions possible; therefore, it is recommended to maintain the greatest number of permanent teeth when possible through restorative treatment.

In cases of severe systemic pathology or severe intellectual disability (ASA IV), dental care is provided under general anesthesia in a hospital setting [35].

The most frequently performed treatments in patients with disabilities were tartrectomy and obturation, whereas in patients with odontophobia, tartrectomy was performed, followed by wisdom tooth extraction and placement of dental implants. Most studies have found a higher frequency of extractions in patients with intellectual disabilities owing to their poor oral status at the time of dental care [29,30,32]. Despite this, we can verify that in studies that include a population of young adults, there is a higher percentage of restorative and preventive treatments [12,16,18–20] than in studies in which the registered age of the patients is higher, with a higher percentage of extractions and surgical treatments [7,15,17,24]. A study by Cortezo et al. regarding the treatment needs of non-cooperative patients with intellectual disabilities, operated under general anesthesia, indicated that 83.9% required extractions compared to the rest of the treatments [40]. Other studies indicate that in the younger population, 73% of dentists perform endodontic treatments when possible, although the most frequently performed treatment is still extraction, accounting for 54% of the treatments [40]. Studies that collected data on older adults, such as that by Limeres et al. [41], showed a high percentage of patients who underwent extractions (91.8%) compared with 71.7% who required restorative treatment. In a study by Cuesta et al. [42], which included patients between 18 and 71 years of age, extractions represented 84.6%, compared with 59.8% for restorations.

Regarding the sedatives used, propofol-fentanyl was the most used alternative in our sample, followed by nitrous oxide. Previous studies [43] found that NOS at 30–50% is effective as a sedative and analgesic in patients with ASA I and II. Other studies found similar effects of midazolam and nitrous oxide in controlling anxiety during dental treatments [44-46]. However, it must be noted that the sample of our study included a large number of patients with disabilities, which necessitates the use of sedation techniques, such as propofol-fentanyl, which requires less collaboration on the part of the patient and has a longer-lasting effect. Furthermore, its rapid

onset of action and analgesic properties make it a suitable option for patients whose oral condition is generally more deteriorated.

Regarding the age of the patients, we found that the sedative drugs most frequently used for young patients were nitrous oxide (18.20 ± 8.39 years) and midazolam (21.15 ± 9.96 years). These results are consistent with those of other studies, where nitrous oxide was sometimes combined with midazolam to add its anxiolytic, sedative, amnesic, and hypnotic effects [47-49].

Tartrectomy and fillings, followed by tartectomy, were the most frequently performed dental treatments under nitrous oxide sedation. This is explained by the fact that these treatments are generally minimally invasive, producing minimal discomfort to the patient and of a more limited duration. Furthermore, the average age of the patients in whom nitrous oxide was used corresponded to the lowest age of the entire sample (18.20 ± 8.39 years). The treatments performed most frequently with the combination of propofol and fentanyl were obturation, tartrectomy and deeper obturation, and obturation and extraction of the root remains. These treatments, which involve combinations of several actions, may require more time, which is why deeper sedatives are typically used. Finally, under the effects of midazolam, tartrectomy and filling were performed more frequently in younger patients.

This study had several limitations. First, as this was a prospective study of patients treated at a university center, the sample of subjects may not be sufficient to assume the results as sufficient scientific evidence.
The majority of treated patients had intellectual disabilities, as there is not a wide range of centers where these treatments are performed. The dental treatments of patients seen at a specialized university dental center differ from those that can be offered at other centers to patients who are unable to cooperate under local anesthesia.

The majority of patients who are unable to collaborate have difficulty accessing the treatments available in private dental care centers in Spain due to their high cost. However, most public centers do not offer conservative treatment to the entire population among their services.

In conclusion, deep sedation techniques are effective and safe alternatives for oral care of people who are unable to collaborate.

The combination of propofol and fentanyl was the most frequently used alternative in patients who were unable to collaborate due to intellectual disability or carry out longer or more complex treatments.

Inhaled nitrous oxide and midazolam were the sedative techniques of choice for simpler oral treatments, such as tartrectomies, shallow obturations, and shorter interventions, or in younger patients.

A few complications due to the use of sedatives were recorded in this study, and their resolution was complete. However, these techniques must be performed by specialized personnel with experience in managing these patients.


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## AUTHOR CONTRIBUTIONS

**Carlos M. Cobo Vázquez:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Visualization, Writing - original draft, Writing - review & editing
**Mª Carmen Gasco:** Conceptualization, Supervision, Validation, Visualization, Writing - review & editing

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