

# Is dental general anaesthesia in children an outdated concept? A retrospective analysis



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## Abstract

**Aim** The aim of this retrospective study was to determine the prevalence of caries and treatment needs in the collective of patients  $\leq 16$  years of age, who underwent scheduled dental general anaesthesia (DGA) at the University Clinic of Innsbruck from January 2015 to June 2019, with respect to demographic factors.

**Materials and methods** A retrospective analysis of children's diagnoses, demographics, and dental treatment under general anaesthesia in Innsbruck, Austria, from 2015 to 2019 was performed. Anonymised demographic data (age; gender; the presence or absence of general disease or disablement; parents' first language (German- (GS) or non-German-speaking (non-GS), reflecting ethnicity; and the number of teeth restored and extracted under DGA were collected from patients' files. Data was analysed by means of descriptive and comparative statistics.

**Results** The main group consisted of 545 subjects at a median age of 5.3 (IQR 4.4-6.6) years, who had exclusively primary teeth and/or first molars that received restorations or were extracted. Of the subjects, 84.4% were classified with uncooperativeness due to dental anxiety and 15.6% with systemic diseases or intellectual and/or physical disablement. In this group, 47.9% were GS and 52.1% were non-GS or had GS or non-GS parents. In the total sample, 5 (IQR 3-7) primary teeth were restored and 4 (IQR 4-7) extracted. Subgroup analysis revealed statistically significant differences in the number of extracted primary teeth between children with and without systemic diseases or disablement - 3 (IQR 1-5) versus 4 (IQR 2-7) - and between children of GS and non-GS parents - 4 (IQR 2-6) versus 5 (IQR 3-7.8). Zero (IQR 0-0) first molars were filled and extracted.

**Conclusions** Within the study collective of children in poor oral health, the offspring of non-GS families were overrepresented (compared to their prevalence in the total population) and displayed a higher prevalence of deep caries than those of GS parents. By intensifying and special gearing of prophylactic measures to the non-GS population and promoting the parents' insight into the importance of oral hygiene and regular dental attendance, the demand for scheduled DGA might be greatly reduced. In the small share of children who suffer from severe diseases or disablement and are thus unable to cooperate with home care or dental treatment, DGA will remain the treatment of choice.

**KEYWORDS** Dental general anaesthesia; Caries prevalence; Childhood caries; Special needs; Ethnicity.

## Introduction

Dental caries is a theoretically preventable disease [Balakrishnan et al., 2000]. However, the Global Burden of Disease Study 2010

listed the global prevalence of dental caries in permanent teeth first (35.29%) and that of dental caries in baby teeth tenth (9.02%) of the 50 most common sequelae (out of 1160 sequelae of 289 diseases and injuries that cause disability) [Vos et al., 2012]. The World Health Organization has defined global goals for oral health 2020, e. g. absence of caries in 80% of six-year-old children and a maximum mean decayed-missing-filled-permanent teeth (DMFT) score of 1.5 (at least 1 tooth of which filled) in 12-year-olds [Hobdell et al., 2003].

In the state of Tirol, Austria, oral health surveys according to WHO criteria [WHO, 2013] have assessed a continuous caries decline from 2001 (mean decayed within dentin-missing-filled-primary teeth (d3mft) score 2.1) to 2011 (mean d3mft score 0.7), but again an increase in 2016 (mean d3mft score 1.0) in 6-year-old children. In the same age group, 49% were caries-free in 2001, 74% in 2011, and 70% in 2016 [Österreichisches Bundesinstitut für Gesundheitswesen, 2003; Bodenwinkler et al., 2012; Bodenwinkler et al., 2017]. Ethnic minority status and parents' low socioeconomic and educational level have been identified as children's caries risk factors in Tirol and its neighboring state Vorarlberg [Bodenwinkler et al., 2012; Bodenwinkler et al., 2017; Wagner et al., 2014]. Table 1 illustrates the demographic change of the resident population of Tirol from 2014 to 2018 [Dobler and Kaiser, 2015; 2016; Bonn and Kaiser, 2019]. The refugee wave from Asia and Africa to Europe that had its peak in the year 2015 has had minor effects on the structure of the population in Tirol. In 2017, around 93,000 refugees and persons with subsidiary protection status, most of them from Afghanistan and Syria, were living in Austria [Schrüffl and Sowinetz, 2017]. At the end of the year 2017 4,745 applicants for asylum were provided with basic supplies (e. g. food, accommodation, health insurance, medical care, and much more) in Tirol [Mohr, 2019]. The working group for preventive medicine and health promotion (Avomed) has conducted a statewide education programme in Tirolean primary schools and kindergartens for the past 35 years and has certainly played an important role in the gradual reduction of children's caries prevalence. However, a polarisation of caries in marginal groups has been observed [Bodenwinkler et al., 2012; Bodenwinkler et al., 2017]. In children and adolescents who are afflicted with carious lesions and referred to dental general anaesthesia (DGA), preventive measures have failed. Non-amenability to regular dental treatment may be due to either the presence of systemic diseases or mental and/or physical

	Total population	Foreign residents	From non-EU states	From Germany	From Ex-Yugoslavia	From Turkey	From Italy
2014	n= 728,826 (100%)	13.1%	4.8%	4.3%	2.4%	1.6%	0.8%
2015	n= 739,139 (100%)	14.3%	5.5%	4.4%	2.5%	1.6%	0.9%
2018	n= 754,709 (100%)	15.9%	5.8%	4.7%	2.5%	1.5%	1%

*n*, number

**TABLE 1** The resident population of Tirol in the years 2014 to 2018 [Dobler and Kaiser, 2015; 2016; Bonn and Kaiser, 2019].

disablement or to dental anxiety or uncooperativeness. Several studies have evaluated the medical diagnoses of paediatric patients treated under DGA. Takriti et al. reviewed the records of children who underwent DGA at a university clinic and three private practices in Germany [Takriti et al., 2019]. Young age and dental caries and its complications were the most important indications for the use of DGA. Koberova Ivancakova et al. found a percentage of about 62% medical disability (systemic or intellectual) in their cohort of Czech preschool and young schoolchildren [Koberova Ivancakova et al. 2019]. Dental treatment of primary teeth was more frequently performed in healthy children, whereas in the permanent dentition, medically compromised children required more extractions and restorations. A Finnish study in children aged 0 to 13 years identified non-cooperation and fear as the most common reasons for the provision of DGA. In that cohort, the mean number of treated teeth per patient was  $9.4 \pm 4.2$  and the predominant treatment was restorative therapy [Savanheimo and Vehkalati, 2014]. Immigrants had significantly more treatments performed than non-immigrants ( $10.7 \pm 4.6$  versus  $9.1 \pm 4.0$  teeth).

DGA data have value in highlighting the impact and inequalities associated with dental decay on children and could be used to target and evaluate health improvement programs [Mortimore et al., 2017]. The purpose of this retrospective study was to assess demographic parameters, diagnoses, caries prevalence, and treatment needs in the collective of children and adolescents who underwent DGA in Innsbruck, Austria, from January 1st 2015 to June 30th 2019, so as to contribute relevant data to health care policies and to discuss the question if DGA in children might be evitable at all.

## Materials and methods

### Subjects

The study sample was composed of all consecutive patients  $\leq 16$  years of age who had scheduled DGA at the University Clinic of Dental Prosthetics and Restorative Dentistry of Innsbruck (Austria) from January 1st 2015 to June 30th 2019. The cohort consisted of non-pain patients (suffering neither acute nor enduring pain) who were unamenable to dental treatment under local anaesthesia due to systemic diseases or intellectual and or physical disablement or due to dental anxiety or uncooperativeness. Uncooperative children or adolescents without disease or disablement were admitted to DGA only upon a dentist's referral that affirmed a failure of attempted treatment under office conditions. Children or adolescents diagnosed with systemic diseases or intellectual and or physical disablement were alternatively referred by the Department of Paediatrics or paediatricians in practice. At the first visit, the medical, dental, and family history was taken, a clinical examination was done, and (in case of a sufficient cooperation) an orthopantomogram (OPG) was taken if not provided by the referring dentist. After an informed consent was obtained from the parent or legal guardian, the child or adolescent was scheduled for DGA. Following a pre-operative assessment of suitability for general anaesthesia at the outpatient clinic of the Department of Anaesthesiology and Critical Care Medicine, DGA was performed in the course of a day-unit stay. Under

endotracheal anaesthesia, a professional tooth cleaning and an examination were performed and - when considered necessary - intraoral radiographs were taken. Carious teeth with lesions ICDAS D1 or greater were excavated and restored with composite restorations and deeply carious teeth (displaying vital or non-vital pulp expositon upon caries excavation) were extracted. In order to keep the duration of general anaesthesia short and to assure postoperative (long-term) absence of pain, pulp capping, pulpotomy, or endodontic treatments were not performed. Admission to DGA and dental treatment were carried out and documented by changing consultants on duty according to the guidelines described above.

### Study design and data acquisition

The present study was conducted in accordance with the ethical standards of the institutional ethics committee and with the Helsinki Declaration of 1975, as revised in 2013. For this type of study (a retrospective analysis of anonymised data collected from patients' files), *de jure*, ethical approval is not required. Parents' consent to the use of their and their children's data for statistical and research purposes was obtained as part of admission to DGA. Data collection and analysis were performed in the course of a thesis that was approved by the Medical University of Innsbruck. The following data were extracted from electronic files, coded by numbers, and listed in a table (Excel, Microsoft, Redmont, WA, USA): Date of birth; date of DGA; gender; parents' or single parent's first language (German or not German), reflecting the absence or presence of a migration background; presence of either a systemic disease or intellectual and or physical disablement or of dental anxiety or uncooperativeness; availability of a preoperative OPG (dating back at maximum 6 months from the date of admission to DGA); number of primary and permanent teeth and surfaces restored under DGA; number of primary and permanent teeth extracted under DGA. With a similar cultural and socioeconomic background and notion of oral health within Austria and its neighboring German-speaking (GS) countries presumed, Austrian children and children of GS immigrants (from Germany, Switzerland, or South Tirol, Italy) were subsumed as children of GS parents.

### Data analysis

Standard descriptive statistics was used to summarise the data. Qualitative variables are reported as absolute and relative frequencies and quantitative variables as median (interquartile range), unless otherwise stated. The distribution of continuous variables was determined by Kolmogorow-Smirnow test. In case of a normal data distribution, t-test, and in case of not normally distributed data, Mann-Whitney U test was used to assess statistical significance in differences. Group-specific differences of categorical variables were assessed with Pearson chi-square test. Statistical analysis was conducted using the IBM SPSS version 21 (IBM Corporation, Armonk, USA). *p*-values  $\leq 0.05$  were regarded as statistically significant.

## Results

According to the nature of teeth restored and or extracted under DGA, subjects were divided into two groups: Children,

who had exclusively primary teeth and first molars restored or extracted, were assigned to the main group; children or adolescents, who had (also) other permanent teeth treated, were allocated to the side group.

### Results of the main group

#### Subjects

The main group (n = 545) was composed of 312 (57.2%) males and 233 (42.8%) females. Median age was 5.3 (4.4-6.6) years in the total sample. Differences in age between males and females were not statistically significant (5.2 (4.3-6.5) versus 5.4 (4.6-6.7) years (p = 0.78; Mann-Whitney U test).

#### Language

Two hundred sixty-one (261) (47.9%) children had GS and 284 (52.1%) had non-GS parents.

#### Diagnoses

Four hundred sixty (460) (84.4%) individuals underwent DGA due to dental phobia or uncooperativeness and 85 (15.6%) were diagnosed with systemic diseases or intellectual and/or physical disorders.

#### Orthopantomogram

In 545 (83.4%) patients a preoperative OPG was available, whereas 90 (16.5%) were not cooperative enough to have an OPG taken. In 29 (34%) of all patients with systemic diseases or disablement and in 61 (13.3%) of all patients with dental phobia or uncooperativeness the taking of an OPG was impossible (p < 0.001; Pearson chi-square test).

#### Dental treatment under DGA

In the total collective, 5 (3-7) primary teeth and 8 (4-13) surfaces of primary teeth were treated with restorations and 4 (2-7) primary teeth were extracted. Distribution of restored primary teeth and surfaces and of extracted primary teeth by gender, language affiliation, and diagnoses are shown in Table 2. Zero (0-0) (mean 0.6 ± 1.2) first molars and zero (0-0) (mean 0.9 ± 2.2) surfaces of first molars were restored. Zero (0-0) (mean 0.04 ± 0.3) first molars were extracted.

### Results of the side group

#### Subjects and orthopantomogram

In 46 patients, aside from primary teeth and first molars, other permanent teeth were treated under DGA as well. Median age in this group was 11.2 (9-13.2) years. Twenty-two (47.8%) individuals were male and 24 (52.2%) female; 29 (63%) had GS and 17 (37%) had non-GS parents. In this group, 28 (60.9%) individuals displayed systemic diseases or disablement and 18 (39.1%) suffered from dental phobia or uncooperativeness.

In 18 (39%) an OPG was available.

#### Dental treatment under DGA

Zero (0-0.3) primary teeth and 0 (0-0.5) surfaces of primary teeth were restored and 0 (0-3) primary teeth were extracted.

Five (4-8) permanent teeth and 13 (3-21) surfaces of permanent teeth were restored and 0.5 (0-3.3) permanent teeth (exclusively first molars) were extracted.

### Detailed medical diagnoses of both groups

Altogether 113 individuals (85 of the main and 28 of the side group) suffered from systemic diseases or intellectual and/or physical disablement and were assigned to the following diagnoses. Chromosomal disorders and hereditary diseases with inherent developmental physical and/or mental disturbances (n = 42), e. g. Down's syndrome (n = 13), Angelmann syndrome (n = 3), Cri du Chat syndrome (n = 3); hereditary metabolic disorders such as Wilson syndrome (n = 1), glutaric aciduria (n = 1), or Smith-Opitz syndrome (n = 1); muscular dystrophy/

	Primary teeth	Restored	Restored surf.	Extracted
Males		5 (3-7) <sup>a</sup>	9 (5-13) <sup>b</sup>	4 (2-6) <sup>c</sup>
Females		4 (3-7) <sup>a</sup>	7 (7-12) <sup>b</sup>	4 (2-7) <sup>c</sup>
German speaking		5 (3-7) <sup>d</sup>	8 (4-12) <sup>e</sup>	4 (2-6) <sup>f</sup>
Non-German speak.		5 (3-7) <sup>d</sup>	9 (4.3-13) <sup>e</sup>	5 (3-7.8) <sup>f</sup>
Disease/disablement		5 (2-7) <sup>g</sup>	7 (3.5-12) <sup>h</sup>	3 (1-5) <sup>f</sup>
Dental phobia/uncooperativ.		5 (3-7) <sup>g</sup>	8 (5-13) <sup>h</sup>	4 (2-7) <sup>f</sup>

ap= 0.09; bp=0.03; cp= 0.91; dp= 0.55; ep= 0.19; fp< 0.001; gp= 0.41; hp= 0.12; Mann-Whitney U test. - Statistically significant differences are marked in grey.

**TABLE 2** Distribution (median (interquartile range) of restored primary teeth, restored surfaces of primary teeth, and extracted primary teeth; by gender, language affiliation, and diagnoses.

myopathy (n = 2); neurofibromatosis type 1 (n=1); Glanzmann's thrombasthenia (n = 1); and others. Mental retardation and/or delayed psychomotoric development (not further specified) (n = 20). Seizure disorders (not further specified) (n= 20). Cardiac diseases or malformations (n= 21). Autism, attention deficit disorders, or perceptual disturbances (n = 10).

## Discussion

DGA is a widely used method to perform dental treatment in uncooperative children. Although considered safe when performed by a well-equipped and trained team [Roberts et al. 2020], a certain risk of anaesthetic complications remains [Gonzalez et al., 2012; De Francisci et al., 2013]. Furthermore, the expense for DGA by far exceeds the costs for conventional dental treatment under office conditions [McAuliffe et al., 2017]. The aim of this retrospective study was a breakdown of demographic parameters, diagnoses, caries prevalence, and dental treatment needs in the collective of children and adolescents undergoing scheduled DGA in the years 2015 to 2019 at the hospital center of Innsbruck, Austria. Based upon our data, we discuss the question up to what extent DGA in children might be evitable. With respect to the reasons why dental treatment in private practice was unsuccessful and refrained from, the study collective was divided into the two collectives: Children or adolescents suffering from general diseases or intellectual and/or physical disablement, and children with dental phobia or uncooperativeness. In the main group (aged 5.3 (4.4-6.6)), the proportion of children with dental phobia or uncooperativeness outweighed the share of individuals suffering from diseases or disablement (84.4% versus 15.6%). Regarding the percentage (around 10%) of non-GS foreign residents in Tirol (2015 and 2018) (Table 1), children of non-GS families (52.1% of our sample) were by far overrepresented. The refugee movement from Asia and Africa that had its peak within our study period brought some thousands of protection-seeking persons to Tirol [Mohr, 2019] and perhaps had some impact on the composition of our study population. However, immigrants from successor states of former Yugoslavia and from Turkey have constituted the majority of NG-immigrants [Dobler and Kaiser, 2015; 2016; Bonn and Kaiser, 2019]. With respect to a total of 107,923 children ≤15 years (14.6% of a total of 745,707 inhabitants) living in Tirol (December 2018), the number of children (around 130 per year) who underwent scheduled DGA in the state's hospital center was rather small. This reflects the state's generally high level of oral health consciousness and care.

A polarization of caries in high risk groups has been associated with a low level of education, low socioeconomic status, and

a migration background, which are frequently combined [Bodenwinkler et al., 2012; Bodenwinkler et al., 2017]. A precedent study that assessed caries prevalence in a sample of 1,703 children (aged  $5.6 \pm 2.53$  years) who underwent scheduled DGA in Innsbruck in the years 2003 to 2014, found a distribution of 57.7% children of GS and 42.3% of non-GS parents [Schnabl et al., 2018]. In this study, in the total collective, 5 (3-7) primary teeth received restorations and 4 (2-7) primary teeth were extracted, which are quite similar rates to those found in the previous study. Our results reflect a high caries prevalence compared to the caries prevalence in 6-year olds in the general population of Tirol and Austria (d3mft score 1.0 and 2.0, respectively), assessed in a 2016 cross-sectional survey [Bodenwinkler et al., 2017]. The higher extraction rate in the non-GS group (5 (3-7.8) versus 4 (2-6) in the GS group outlines a blatant lack of oral health literacy in non-GS parents who seem to seek dental treatment only in the presence of obvious decay. Also in the group of children suffering from systemic diseases or disablement, the extraction rate was significantly higher than in the dental phobia group (4 (2-7) versus (3 (1-5)).

In order to elucidate the reasons why DGA is required in children with systemic diseases or physical and/or intellectual disablement, a categorisation of the patients' main diagnoses (taken from their files) into rough groups was attempted. The authors are aware that - due to category overlap - this differentiation is certainly somewhat vague. For example, seizure disorders may well be associated with mental retardation or be part of an encephalopathy caused by a chromosomal disorder. Nevertheless, in the light of this outline of diagnoses, it is evident that in severely impaired children and adolescents non-cooperation with regular dental treatment is to be expected and likely to persist also in adulthood. In these cases DGA presents a suitable treatment option. Bodily defects (such as cardiac malformations), however, implicate an increased risk of anesthetic complications and require a specialised, experienced and well-equipped anesthetist and staff. In the side group of children and adolescents (age 11.2 (9-13.2) that had, aside from primary teeth and first molars, other permanent teeth restored under DGA as well, the share of individuals with systemic diseases or intellectual and/or physical disablement was higher (60.9%) than in the main group of younger children, according to expectation. In this group, the extraction to restoration ratio of permanent teeth was in favour of restorations, which may be partly due to the just recent eruption of permanent teeth. However, 0.5 (0-3.3) first molars were deeply carious and displayed vital or non-vital pulp exposition on excavation and were thus extracted at a young age. Although single visit endodontic treatment (with or without general anaesthesia) has been considered a feasible treatment option in primary and permanent teeth alike [Chang and Kim, 2017; Manfredi et al., 2016; Ng et al., 2008], according to internal directives of the University Clinic of Dental Prosthetics and Restorative Dentistry of Innsbruck, possible complications of pulp therapy or endodontic treatment such as pain, swelling, fistula, radiologic failure, and the consecutive need of tooth extraction are not changed [Manfredi et al., 2016]. The difference in availability of a preoperative OPG between the main (83.4%) and the side group (39%) reflects the difference in the ratio of subjects with disease/disablement and those with dental phobia, which was expectedly higher in the side group of older age.

Limitations of this study are owed to its retrospective character. Multiple operators were involved in patient admission, diagnosis, and treatment. However, all operators were obliged to comply with the hospital's strict guidelines as described above. Further parameters of interest such as the parents' socio-economic

status or the provenance of immigrants were not available from patients' files and could be assessed in future investigations with a prospective study design.

## Conclusions

Within the study collective of children in poor oral health, the offspring of non-GS families was overrepresented and displayed a higher prevalence of deep caries than that of GS parents. The general caries decline, which results from painstaking educational work in kindergartens and schools, needs to be pursued in high-risk groups. The implementation of a tangible set of measures might greatly reduce the demand for scheduled DGA. Prophylactic measures should be intensified and specially geared to the non-GS population to increase parents' insight into the importance of oral hygiene and a continuous dental attendance from early infancy. Counseling should thereby start during pregnancy. In the presence of carious lesions, alternative treatment methods (e. g. behaviour management, hypnodontia, or nitrous oxide sedation) should be considered. In the small share of children that suffer from severe diseases or disablement and are thus unable to cooperate with home care or dental treatment, DGA will remain the treatment of choice.

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