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Cross-Sectional Analysis of Dental Treatment Procedures Performed Under General Anesthesia or Sedation

Genel Anestezi veya Sedasyon Altında Yapılan Diş Tedavi Prosedürlerinin Kesitsel Analizi

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This study was presented as a poster at the 1st National Erciyes Anesthesia of Dendistry Symposium (Turkish Anesthesia and Reanimation Congress), 9 April 2022, Online.

ABSTRACT Objective: Although dental procedures can be performed under local anesthesia, some special cases may require general anesthesia (GA) or sedoanalgesia (SA). We aimed to investigate and compare the data of patients who underwent dental procedures under GA or SA. **Material and Methods:** The data of patients who underwent dental treatment under GA and SA in the dental hospital between 2012 and 2014 were analyzed. Demographic data and American Society of Anesthesiology scores duration of dental treatment, type of treatment (extraction, root canal, filling, amputation, extraction, cyst excision), number of procedures (i.e. single or multiple dental procedures), mental health status, muscle relaxant additional data, including use and opioid use, were obtained from anesthesia document. The patients were divided into groups according to the anesthesia method used (i.e. GA or SA). The data of healthy and mentally retarded individuals were also compared within the GA and SA groups. **Results:** The entire cohort included 896 patients. The mean patient age was 8.4+/-8.1 and 8.7+/-8.7 in the GA (n=596) and SA (n=300) groups, respectively. The mean procedure time was 70 (15-175) and 20 (5-50) minutes in the GA and SA groups. The rate of mentally healthy patients in SA was significantly higher than in the GA group (p<0.001). The rate of multiple procedures was significantly higher in the GA group than in the SA group (p<0.001). **Conclusion:** SA can be performed in short dental procedures provided the patency of the airway is maintained. GA may be preferred in mentally retarded and healthy patients in multiple dental procedures.

Keywords: Dental anxiety; general anesthesia; sedoanalgesia

ÖZET Amaç: Dental işlemler lokal anestezi altında yapılabilse de bazı özel durumlarda genel anestezi (GA) veya sedoanaljezi (SA) gerektirebilir. Bu çalışmamızda, GA veya SA altında dental prosedür uygulanan hastaların verilerini araştırmayı amaçladık. **Gereç ve Yöntemler:** 2012-2014 yılları arasında bir diş hastanesinde GA ve SA altında dental tedavi uygulanan hastaların verileri incelendi. Demografik veriler, "American Society of Anesthesiology" skorları diş tedavi süresi, tedavi türleri (çekim, kanal, dolgu, ampütasyon, detertraj, kist eksizyonu ve diğer işlemler), prosedür sayısı (tek veya çoklu diş işlemi), zihinsel sağlık durumu, kas gevşetici ve opioid kullanımı dâhil olmak üzere ek veriler anestezi fişlerinden alındı. Hastalar kullanılan anestezi yöntemine göre (GA veya SA) gruplara ayrıldı. GA ve SA grupları içinde de sağlıklı ve zihinsel engelli bireylerin verileri karşılaştırıldı. **Bulgular:** Tüm kohort 896 hastayı içeriyordu. Ortalama hasta yaşı GA (n=596) ve SA (n=300) gruplarında sırasıyla 8,4+/-8,1ve 8,7+/-8,7 idi. GA ve SA gruplarında ortalama işlem süresi 70 (15-175) ve 20 (5-50) dk idi. SA'da mental olarak sağlıklı hasta oranı GA grubuna göre anlamlı derecede yüksekti (p<0,001). Çoklu işlem oranı GA grubunda SA grubuna göre anlamlı derecede yüksekti (p<0,001). **Sonuç:** SA, havayolunun açıklığının korunması şartıyla kısa diş prosedürlerinde yapılabilir. Çoklu dental işlemlerde, zihinsel engelli ve sağlıklı hastalarda GA tercih edilebilir.

Anahtar Kelimeler: Dental anksiyete; genel anestezi; sedoanaljezi

Dental procedures performed in children, mentally disabled patients, or patients with psychiatric disorders may necessitate general anesthesia (GA) or sedoanalgesia (SA) due to non-compliance, problems of cooperation, and severe anxiety.[1] Dental anxiety is described as fear, anxiety, stress, or irritability in a dental setting.[2,3] It was reported that severe dental anxiety was associated with inferior oral health and low quality of life. Oral and dental health centers which give their patients the

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chance to undergo dental procedures under GA or SA can prevent these unfavorable consequences. The concept of dental general anesthesia (DGA) corresponds to the performance of GA by an anesthesiology team in adult or pediatric dentistry practice for providing optimal dental care.[4,5]

American Academy of Pediatric Dentistry determined the indications and contraindications of DGA in children and adolescents.[6,7] In line with these guidelines, Helsinki Public Dental Service suggested DGA in children, adolescents, and adults with mental and physical disabilities.[7-9] However, it should be considered that DGA can be a source of significant postoperative morbidity. During the last few years, sedation has also been suggested as another anesthetic technique in these patients' dental treatments.[10] Since the anxiety associated with dental treatments can be relieved in most cases via partial suppression of consciousness by sedation, this method has gained popularity. Subsequently, American Dental Association reported a clinical guideline on sedation for dental procedures.[11] In this guideline, *conscious sedation* has been defined as a depressed level of consciousness during which the patient retains control over his protective reflexes and can respond to verbal commands. This guideline reported that patients could be safely treated under conscious sedation.

In Türkiye, Turkish Anesthesia and Reanimation Association published the Anesthesia Practice Guidelines in Dentistry in 2015 and updated it in 2022. In the Turkish Anaesthesiology and Reanimation Society Guideline, it is mentioned that safe anesthesia precautions should be followed during the GA or SA procedure. During the SA procedure, the breathing of the patients should be monitored and the necessary team and medical supplies should be available for intubation applications in case of respiratory arrest. Although both GA and conscious sedation methods are frequently performed in Türkiye due to its relatively young patient population, the literature is scarce in this regard.

In our research, we wanted to share our experience in dental treatments with both SA and GA. While dentists are operating in the area close to the respiratory tract, it becomes more meaningful that anesthetists protect the respiratory tract. We tried to prefer SA as much as possible to the extent that we can protect the airway. This study aimed to investigate the practicability of performing GA and sedation in pediatric and adult patients' dental procedures.

MATERIAL AND METHODS

This study was approved by the University of Health Sciences Ankara Keçiören Training and Research Hospital Clinical Research Ethic Committee (date: March 11, 2020, number: 2012-KAEK-15/2062). Pediatric and adult patients who underwent a dental procedure under GA or SA in Oral and Dental Health Hospital between July 2012 and March 2014 constituted this study's target population. General anesthesia was performed in patients with mental disabilities and pediatric patients who need lengthy procedures such as root canal treatments (RCTs). One of the main reasons for this approach was maintaining airway patency and preventing aspiration of solid particles or liquids by performing endotracheal intubation. On the other hand, SA was performed in disabled or healthy patients who either necessitated a short procedure or had comorbidities associated with high anesthesia-related risks. Dental treatments with SA were performed with the patient's head level 45 degrees above. During the procedure, patients were monitored [temperature, heart rate, oxygen saturation (SO_2) and end-tidal carbon dioxide]. In patients who underwent the procedure under GA, the endotracheal tube was fixed to the lip. Complications related to the patient were also noted on the anesthesia record (vomiting, dislocation of the tube, weezing after extubation, etc.

Data including demographic parameters (i.e. age, gender), type of anesthesia (GA/SA), American Society of Anesthesiologists (ASA) score, type of procedure [tooth extraction (TE)/dental filling (DF)/RCT/curettage/pulp capping (PC)/cyst excision/amputation/others], duration of the procedure, general status (healthy vs. disabled), type of muscle relaxant used in GA cases (rocuronium, atracurium, cisatracurium), use of opioids and type of hypnotic used (propofol,) were retrospectively reviewed and recorded. Individuals younger than 3

years of age were excluded from the study. Patients with incomplete data were excluded. Study patients were divided into groups (GA and SA) as per the type of anesthesia given during dental procedures and variables in healthy and mentally retarded individuals within the GA and SA groups were compared. Since RCT, curettage procedures were performed only under GA, statistical analysis was not performed. Filling, cyst excision, extraction and amputation procedures that can be performed under SA and GA were analyzed statistically.

Data analysis was performed using IBM SPSS Statistics version 17.0 software (IBM Corporation, Armonk, NY, USA). The normal distribution of continuous variables was tested by the Kolmogorov-Smirnov test. Descriptive statistics for continuous variables were expressed as means±standard deviations, or medians (minimum-maximum), where appropriate. Numbers and percentages were used for presenting categorical data. The mean differences between groups were compared by Student's t-test. The Mann-Whitney U test was used for comparing the continuous variables which were not normally distributed. Pearson's χ^2 test was implemented for analyzing categorical data.

On the other hand, in all 2×2 contingency tables used to analyze the relationships between categorical variables, the continuity corrected χ^2 test was used when one cell or more cells had an expected frequency of 5-25. Otherwise, the Fisher's exact test was used when one cell or more cells had an expected frequency of 5 or less. In all RxC contingency tables used to analyze categorical variables, the Fisher-Freeman-Halton test was used if 1/4 or more of the cells had an expected frequency of 5 or less. Bonferroni correction was applied for controlling Type I error for each possible comparison. Unless otherwise stated, the p value was considered statistically significant.

RESULTS

The target population consisted of 1,043 patients aged between 3 and 60. Among these patients, 147 were excluded due to incomplete data. Thus, the entire cohort included 896 patients. There were 705 patients younger than 18 who were mentally normal and 80 patients younger than 18 who were mental disabilities. The majority of the cases (n=785) were younger than 18. Twenty two patients were older than

TABLE 1: Demographic and clinical data of the study patients in general anesthesia and sedoanalgesia groups.

	General anesthesia (n=596, 66.5%)	Sedoanalgesia (n=300, 33.5%)	p value
Age (years)	8.4±8.1	8.7±8.7	0.671[a]
Gender			
Male n (%)	330 (55.4)	196 (65.3)	0.004[b]
Female n (%)	266 (44.6)	104 (34.7)	
Groups			
Healthy n (%)	463 (77.7)	264 (88.0)	<0.001[b]
Mentally disabled n (%)	133 (22.3)	36 (12.0)	
ASA			
I n (%)	477 (80.0)	279 (93.0)	<0.001[b]
II n (%)	95 (15.9)	12 (4.0)	
III n (%)	24 (4.0)	9 (3.0)	
Duration of procedure (minutes) (minimum-maximum)	70 (15-175)	20 (5-50)	<0.001[c]
Propofol use n (%)	594 (99.7)	147 (49.0)	<0.001[b]
Fentanil use n (%)	138 (23.2)	43 (14.3)	0.002[b]
Remifentanil use n (%)	246 (41.3)	9 (3.0)	<0.001[b]
Ketamine use n (%)	16 (2.7)	259 (86.3)	<0.001[b]
Midazolam use n (%)	588 (98.7)	297 (99.0)	0.760[d]

[a]Student's t-test; [b]Pearson's χ^2 test; [c]Mann-Whitney U test; [d]Fisher's exact test; ASA: American Society of Anesthesiologists.

18 and mentally normal. There were 89 patients with mental disabilities who were older than 18 (Table 1). While 300 of all patients were treated by SA, 596 underwent GA (Table 2). There was no significant difference between GA and SA groups regarding age (8.4±8.1 vs. 8.7±8.7, p=0.671). The rate of male patients was higher and female patients were lower in the SA group than the GA group (p=0.004). The mean duration of the procedure was 70 minutes [15-175] in the GA group and 20 minutes [5-50] in the SA group (p<0.001). The rate of healthy patients was significantly higher, and mentally disabled patients (12%) was significantly lower in the SA group than the GA group (p<0.001).

Comparative analysis revealed that the rate of TE was significantly higher in the SA group than the GA group (p<0.001). While the rates of cyst excision were similar (p>0.05), the rates of procedures including fissure sealing (FS), DF, PC, amputation, detertrage, and others were significantly higher in the GA than the SA group (p<0.05) (Table 2).

Comparing the healthy patients in the GA group with the mentally retarded patients showed that the mean patient age was significantly higher in the mentally retarded group (p<0.001).While the gender distribution was similar between these subgroups (p=0.943), the ASA score was higher, and the duration of the procedure was longer in the subgroup

TABLE 2: Procedures performed in general anesthesia and sedoanalgesia groups.

	General anestesia (n=596, 66.5%)	Sedoanalgesia (n=300, 33.5%)	p value
TE n (%)	456 (76.5)	292 (97.3)	**<0.001**[a]
Number of extracted teeth	2.9±2.9	3.8±2.5	**<0.001**[b]
	2 (0-18)	3 (0-14)	
FS treatment n (%)	325 (54.5)	63 (21.0)	**<0.001**[a]
Number of teeth undergoing FS	2.3±2.9	0.8±1.8	**<0.001**[b]
	1 (0-16)	0 (0-10)	
DF n (%)	546 (91.6)	72 (24.0)	**<0.001**[a]
Number of teeth undergoing DF	5.4±3.2	0.6±1.4	**<0.001**[b]
	5 (0-19)	0 (0-10)	
PC n (%)	241 (40.4)	18 (6.0)	**<0.001**[a]
Number of teeth undergoing PC	1.2±1.8	0.2±0.7	**<0.001**[b]
	0 (0-10)	0 (0-6)	
Amputation n (%)	169 (28.4)	15 (5.0)	**<0.001**[a]
Number of amputated teeth	0.5±1.0	0.1±0.6	**<0.001**[b]
	0 (0-6)	0 (0-6)	
Detertrage n (%)	122 (20.5)	1 (0.3)	**<0.001**[a]
Number of teeth undergoing detertrage	0.8±1.6	0.01±0.2	**<0.001**[b]
	0 (0-6)	0 (0-4)	
RCT n (%)	355 (59.6)	-	N/A
Number of teeth undergoing RCT	2.0±2.9	-	N/A
	1 (0-18)		
Curettage n (%)	35 (5.9)	-	N/A
Number of teeth undergoing curettage	0.2±0.9	-	N/A
	0 (0-4)		
Number of teeth undergoing cyst excision	0.1±0.5	0.05±0.3	0.058[b]
	0 (0-4)	0 (0-3)	
Other procedures n (%)	74 (12.4)	21 (7.0)	0.013[a]

[a]Pearson's χ^2 test; [b]Mann-Whitney U test; TE: Tooth extraction; FS: Fissure sealing; DF: Dental filling; PC: Pulp capping; RCT: Root canal treatment; N/A: Not applicable.

of mentally disabled patients than the healthy patients (p<0.001). This analysis also elucidated that the rate of fentanil use was higher, and rocuronium use was lower in the mentally disabled patient subgroup than the healthy patient subgroup (p<0.001 and p=0.002). There was no difference between these subgroups regarding the use of other anesthetic agents as per Bonferroni correction (p>0.025) (Table 3).

Comparison within the GA group between the healthy patients and mentally disabled patients revealed that the rates of FS, DF, PC, amputation, RCT, and cyst excision procedures were significantly lower (p<0.025) while the rates of detertrage, curettage, and other procedures were significantly higher in the latter subgroup than the former (p<0.001) (Table 4).

Mean patient age was significantly higher in the mentally disabled patient subgroup than the healthy patient group within the SA group (p<0.001). While gender distribution was similar among these subgroups (p>0.999), the ASA score was higher in the mentally disabled patient group than the healthy patient group (p<0.001). There was no difference between these subgroups regarding the procedure's duration (p=0.192) (Table 4).

Subgroup in the SA group, while the rates of fentanyl and remifentanyl use were significantly higher in the mentally disabled patient subgroup than the healthy patient subgroup (p<0.001 and p=0.014), the rate of ketamine use was lower in the former group than the latter (p<0.001) and the Bonferroni correction revealed that there was no significant difference between these patient subgroups concerning the use of other anesthetic agents (p>0.025) (Table 4).

The FS and DF rates were significantly lower in the subgroup of mentally disabled patients than the healthy patient subgroup in the SA group (p<0.01). While the number of extracted teeth was significantly lower (p=0.024), the number of teeth undergoing detertrage treatment was significantly higher in the mentally disabled patient subgroup than the healthy patient subgroup in the SA group (p=0.007). The Bonferroni correction elucidated that there was no

TABLE 3: Comparison between healthy patients and mentally disabled patients regarding demographic and clinical data within the general anesthesia group.

	Healthy patients n=463	Mentally disabled patients n=133	p value[f]	Total n=596
Age (years)	5.4±4.2	18.9±9.6	**<0.001**[a]	8.4±8.1
Gender				
Male n (%)	256 (55.3)	74 (55.6)	0.943[b]	330 (55.4)
Female n (%)	207 (44.7)	59 (44.4)		266 (44.6)
ASA score				
I n (%)	450 (97.2)	27 (20.3)	**<0.001**[b]	477 (80.0)
II n (%)	8 (1.7)	87 (65.4)		95 (15.9)
III n (%)	5 (1.1)	19 (14.3)		24 (4.0)
Duration of procedure (minutes) (minimum-maximum)	70 (15-125)	77.5 (35-175)	**<0.001**[c]	70 (15-175)
Propofol use n (%)	461 (99.6)	133 (100.0)	>0.999[d]	594 (99.7)
Fentanil use n (%)	87 (18.8)	51 (38.3)	**<0.001**[b]	138 (23.2)
Remifentanil use n (%)	189 (40.8)	57 (42.9)	0.674[b]	246 (41.3)
Atracurium use n (%)	66 (14.3)	24 (18.0)	0.348[e]	90 (15.1)
Cisatracurium use n (%)	149 (32.2)	55 (41.4)	0.049[b]	204 (34.2)
Ketamine use n (%)	13 (2.8)	3 (2.3)	>0.999[d]	16 (2.7)
Midazolam use n (%)	459 (99.1)	129 (97.0)	0.079[d]	588 (98.7)
Rocuronium use n (%)	233 (50.3)	47 (35.3)	**0.002**[b]	280 (47.0)

[a]Student's t-test; [b]Pearson's χ^2 test; [c]Mann-Whitney U test; [d]Fisher's exact test; [e]Continuity corrected χ^2 test; [f]According to the Bonferroni adjustment p<0.025 was considered statistically significant; ASA: American Society of Anesthesiologists.

TABLE 4: Comparison of the healthy and mentally disabled patients within the sedoanalgesia group concerning demographic and clinical data.

	Healthy patients (n=264, 36.3%)	Mentally disabled patients (n=36, 21.3%)	p value[f]
Age (years)	6.9±6.5	21.5±12.0	**<0.001**[a]
Gender			
Male n (%)	172 (65.2)	24 (66.7)	>0.999[b]
Female n (%)	92 (34.8)	12 (33.3)	
ASA score			
I n (%)	262 (99.2)	17 (47.2)	**<0.001**[c]
II n (%)	2 (0.8)	10 (27.8)	
III n (%)	0 (0.0)	9 (25.0)	
Duration of procedure (minutes) (minimum-maximum)	20 (5-50)	20 (15-45)	0.192[d]
Profopol use n (%)	125 (47.3)	22 (61.1)	0.170[b]
Fentanil use n (%)	27 (10.2)	16 (44.4)	**<0.001**[b]
Remifentanil use n (%)	5 (1.9)	4 (11.1)	0.014[e]
Ketamine use n (%)	237 (89.8)	22 (61.1)	<0.001[e]
Midazolam use n (%)	261 (98.9)	36 (100.0)	>0.999[e]

[a]Student's t-test; [b]Continuity corrected χ^2 test; [c]Fisher-Freeman-Halton test; [d]Mann-Whitney U test; [e]Fisher's exact test; [f]According to the Bonferroni adjustment p<0.025 was considered statistically significant; ASA: American Society of Anesthesiologists.

TABLE 5: Comparison of the healthy and mentally disabled patients within the sedoanalgesia and general anesthesia groups concerning dental procedures performed.

	HP		MD		HP, MD.	HP, MD
Dental Procedures	**SA (n)**	**GA (n)**	**SA (n)**	**GA (n)**	**SA p valued**	**GA p valued**
	264 (36.%)	**463 (63.7%)**	**36 (21.3%)**	**133 (78.7%)**		
TE	257 (97.%)	358 (77.3%)	35 (97.2%)	98 (73.7%)	>0.999[a]	0.383[a*]
Number of TE	3.9±2.5	3.0±2.9	3.2±2.7	2.6±2.9	**0.024**[b]	0.051[b]
	4 (0-14)	2 (0-18)	2 (0-12)	2 (0-14)		
FS	62 (23.5%)	282 (60.9%)	1 (2.8%)	43 (32.3%)	**0.008**[c]	<0.001[a]
Number of FS	0.9±1.9	2.5±2.7	0.03±0.2	1.7±3.3	**0.004**[b]	<0.001[b]
	0 (0-10)	2 (0-14)	0 (0-1)	0 (0-16)		
DF	70 (26.5%	431 (93.1%)	2 (5.6%)	115 (86.5%)	**0.011**c	0.024[c]
Number of DF	0.7±1.5	5.4±2.8	0.08±0.4	5.1±4.1	**0.005**b	0.070[b]
	0 (0-10)	5 (0-14)	0 (0-2)	5 (0-19)		
Detertrage	0 (0.0%)	26 (5.6%)	1 (2.8%)	96 (72.2%)	0.120a	<0.001[a]
Number of detertrage	0.0±0.0	0.2±0.9	0.1±0.7	2.8±1.8	**0.007**b	<0.001[b]
	0 (0-0)	0 (0-6)	0 (0-4)	4 (0-4)		
RCT	0 (0.0%)	301 (65.0%)	0 (0.0%)	54 (40.6%)	-	<0.001[a]
Number of RCT	0.0±0.0	2.3±3.0	0.0±0.0	0.9±1.7	-	<0.001[b]
	0 (0-0)	2 (0-18)	0 (0-0)	0 (0-15)		

[a]Fisher's exact test; [a*]Pearson's χ^2 test; [b]Mann-Whitney U test; [c]Continuity corrected χ^2 test; [d]According to the Bonferroni adjustment p<0.025 was considered statistically significant; SA: Sedoanalgesia; GA: General anesthesia; HP: Healthy patients; MD: Mentally disabled; TE: Tooth extraction; FS: Fissure sealing; DF: Dental filling; RCT: Root canal treatment; Number of teeth undergoing DF (number of DF) number of teeth undergoing RCT (number of RCT) number of teeth undergoing detertrage (number of detertrage).

significant difference between these subgroups regarding the rates of other procedures (p>0.025) (Table 5).

Among the 896 patients included in the entire cohort, 204 (22.8%) underwent a single procedure while 692 (77.2%) underwent multiple procedures.

TABLE 6a: Rates of single* procedures as per anesthesia methods and groups.

	General anesthesia	Sedoanalgesia	p value[a]	Total
Healthy patients n (%)	17 (3.7)	155 (58.7)	**<0.001**[c]	172 (23.7)
Mentally disabled patients n (%)	2 (1.5)	30 (83.3)	**<0.001**[d]	32 (18.9)
p values[b]	0.272[e]	0.008[d]		0.187[c]
Total n (%)	19 (3.2)	185 (61.7)	**<0.001**[c]	204 (22.8)

*Single procedure indicates that one procedure was performed during anesthesia.

a: The comparisons between types of anhestesia, b: The comparisons between healty control and mentally disabled groups, c: Pearson's χ2 test, d: Continuity corrected χ2 test, e: Fisher's exact test.

TABLE 6b: Rates of multiple* procedures as per anesthesia methods and groups.

	General anesthesia	Sedoanalgesia	p value[a]	Total
Healthy patients n (%)	446 (96.3)	109 (41.3)	<0.001	555 (76.3)
Mentally disabled patients n (%)	131 (98.5)	6 (16.7)	<0.001	137 (81.8)
p values[b]	0.272[e]	0.008[d]		0.187
Total n (%)	577 (96.8)	115 (38.3)	<0.001	692 (77.2)

*Multiple procedure indicates that at least two procedures such as DF+TE or DF+TE+PC were performed during the same session; DF: Dental filling; TE: Tooth extraction; PC: Pulp capping.

a: The comparisons between types of anhestesia, b: The comparisons between healty control and mentally disabled groups, c: Pearson's χ2 test, d: Continuity corrected χ2 test, e: Fisher's exact test.

SA method was mostly preferred for single procedure in healthy and mentally disabled patients (p<0.001). However, the GA method was preferred for some single procedures, such as extraction of the impacted tooth, which could be challenging to perform under SA. The GA rates were 3.7% and 1.5% in healthy patients and mentally disabled patients, respectively (Table 6a).

Our analysis also revealed that the rate of multiple procedures was significantly higher in the GA group than the SA group for healthy patients, mentally disabled patients, and globally (p<0.001). While the rates of multiple procedures were similar between the subgroups of healthy and mentally disabled patients in the GA group (p=0.272), the rate of multiple procedures was significantly higher in healthy patients in the SA group than in patients with mentally disabled (p=0.008) A review of the entire study cohort revealed that the multiple procedure ratios were statistically similar between healthy and mentally disabled patients (p=0.187) (Table 6b).

DISCUSSION

It is widely accepted that the selection of dental anesthesia method should be based on the patient's general status and the dental procedure.[12,13] The mental health of the patient is an essential criterion during this selection process. In mentally disabled patients, providing the airway's patency is challenging under SA considering that these patients have profuse amounts of oral secretions and the patient is not intubated. Therefore, GA is preferred for the lengthy dental procedures performed in these patients.[9]

In a Japanese study, the researchers reviewed the data of 163 mentally disabled patients aged between 2 and 53 who underwent dental procedures under GA.[14] These authors reported that the most common dental procedures performed were conservative restorations, DF, TE, and endodontic procedures. In line with this, DF and TE were the most frequent procedures we performed in our mentally disabled patients. Comparison between the GA and SA groups concerning dental procedure types revealed that FS,

DF, PC, amputation, and detertrage were more frequently performed under GA while TE was more often performed under SA. Of note, RCT procedures were solely performed under GA since they are lengthy procedures, and this approach can easily maintain patency of the airway. This approach is in accordance with Sitkin et al., who recommended that lengthy dental procedures of mentally disabled patients be performed under GA.[15] As such, mentally disabled patients who were candidates for multiple procedures (i.e., the performance of at least 2 procedures during the same session) were initially evaluated under sedation, and GA was given if there were indications for multiple procedures.

In our study, 96.8% of the multiple procedures were performed under GA. Among all dental procedures performed under SA, 38.3% were multiple procedures, and most of these patients were healthy individuals. These findings indicate that the feasibility of performing multiple procedures under SA was significantly higher in the healthy patient group than the mentally disabled patient group. On the other hand, GA was preferable in the multiple procedures of mentally disabled patients. In our routine practice, we preferred SA for the single procedures of mentally disabled patients, as previously suggested.[16]

We could perform dental procedures such as TE, DF, FS, PC, amputation, and cyst excision under SA or GA in patients from various age groups. In 2016, the American Food and Drug Administration reported that the central nervous system of children under the age of 3 could be damaged by exposure to general anesthetics for more than 3 hours.[16,17] Therefore, we did not perform GA in children younger than 3.

Campbell et al. reviewed the data of 3661 patients, 9.6% of whom underwent dental procedures under GA.[17] Among these 351 patients, 46 were younger than 3. Nasal endotracheal intubation, flexible laryngeal mask airway, or nasal cannula insertion techniques were implemented for airway management. Although they noted that procedures that were predicted to last longer than 45 minutes were intubated, the decision regarding airway management was given by the anesthesiologist after consulting with the dentist together. They also determined that opioids and benzodiazepines were not preferred since they interfered with the patients' quick recovery and discharge.

In our study, we performed nasal intubation in 3 patients who necessitated intra-oral measurements and oral endotracheal intubation in other patients who were given GA. We used cuffed endotracheal tubes and placed gauzes with strings onto the mouth floor to reduce the risk of aspiration.

We followed the patients in the SA group for 1 hour and those in the GA group for 3 hours postoperatively. All patients except for one did not have any complications. A 5-year-old patient in the GA group with a recent history of upper respiratory tract infection developed bronchial hyperreactivity. This patient had diffuse ronchi, and he was stabilized with salbutamol inhalation.

Contrary to Campbell et al. we used midazolam and opioids in our patients.[17] Nevertheless, while they recommended that patients be followed for 40 minutes postoperatively, we followed all patients in the GA group for at least 3 hours. Of note, most of our patients had ASA scores of 1 or 2. This finding is in line with the results of Campbell et al.[17]

Campbell et al. reported that the procedure's mean duration was 1.77 hours for the patients who were treated under GA.[17] Since dental procedures are accepted as outpatient surgeries, and there is a strong association between the duration of procedure and discharge time, it was suggested that the optimal surgical time should be less than 90 minutes.[18] In line with this suggestion, the mean duration of the procedure was 77 minutes in our study. We discharged all of our patients on the day of the procedure, including the 5-year-old patient who developed bronchial hyperreactivity.

Özkan et al. reported that the mean procedural duration was 114.5 minutes in their cohort.[19] These authors stated that most of their patients had ASA scores of 1 and 2, and their mean surgical time was relatively longer since most of their cases included complex dental procedures. They also noted that they preferred nasal intubation in these complex surgeries.

In our study, the most complicated procedures were cyst excisions and extraction of impacted teeth. Therefore, our mean duration of the procedure was relatively shorter.

Since agents such as propofol used for anesthesia maintenance in the SA group may lead to respiratory depression, hemodynamic changes, and increased oral secretions, we took special precautions to prevent aspiration.[17] 45-degree reverse Trendelenburg position was used to reduce the risk of aspiration. Respiration rate and SO_2 were followed during SA. These precautions were important for safe sedation procedures.

We preferred propofol for GA induction since dental procedures are considered outpatient surgeries.[20] On the other hand, we mostly used ketamine in the SA group since it exerts sedative and analgesic effects without causing respiratory depression. Midazolam was given to patients simultaneously with ketamine since the latter may otherwise cause delirium and hallucinations.[21] In mentally disabled patients with a seizure disorder, fentanyl or remifentanil was preferred instead of ketamine since ketamine use is contraindicated in this patient population.[22] Remifentanil was preferred over fentanyl in the GA group because it has a relatively shorter half-life, and opioid use was avoided as much as possible. Sevoflurane was used for GA maintenance.

The most frequently used muscle relaxants were rocuronium, cisatracurium, and atracurium in our study cohort. Cisatracurium was preferred over atracurium in mentally disabled patients and those with bronchial hyperreactivity. Neostigmine was given together with atropine during awakening the patients from GA since the former can cause bradycardia and increase the oral secretions.[23] There were no GA-related complications.

It is known that the muscle relaxants and opioids used during GA or SA can affect the hemodynamic parameters. We monitored all patients hemodynamically during the dental treatments, We did not include the hemodynamic data in our analysis since this study did not focus on medication-related hemodynamic effects.

It is important that individuals with mental disabilities need anesthesia in their dental treatments.[24] We also shared the data of individuals with mental disabilities in our study. There are also studies that positively affect the survival of RCT applied to individuals with mental disabilities under GA.[25] However, our approach, which included performing GA or SA, facilitated the dental treatments for these patients. Therefore, data of mentally disabled patients were included in our analysis. Of note, there was a small number of healthy adults in the cohort. There were 89 (total adults: 111; 12.2%) patients over the age of 18 with mental disability. There were only 22 healthy individuals who needed anesthesia. In our medical research, people over the age of 3 were included, as cross-sectional studies aim to provide data on the entire population studied.

CONCLUSION

Good dental health is essential for the well-being of the patients. Patients with special needs and children may necessitate GA or SA for dental procedures. The dentist and the anesthesiologist should make this decision by considering patient-related, anesthesia-related, and dental treatment-related factors. These factors include the patient's age and general health status, anesthesia-related risks and potential complications, benefits expected from the dental treatment, indication of the dental treatment, number of teeth to be treated, and the patient's mental and emotional status. The SA method can be performed for single simple dental procedures of children, mentally disabled patients, and patients with dental anxiety. On the other hand, GA can be preferred for multiple procedures since they have a relatively longer duration. The risk of complications can be reduced by keeping the procedure, selecting appropriate anesthetic agents, and most importantly, maintaining the airway's patency.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Hilal Zengin;* ***Design:*** *Hilal Zengin;* ***Control/Supervision:*** *Hilal Zengin, Necdet İmaç;* ***Data Collection and/or Processing:*** *Hilal Zengin, Necdet İmaç;* ***Analysis and/or Interpretation:*** *Hilal Zengin, Necdet İmaç;* ***Literature Review:*** *Hilal Zengin, Necdet İmaç;* ***Writing the Article:*** *Hilal Zengin;* ***Critical Review:*** *Hilal Zengin;* ***References and Fundings:*** *Hilal Zengin;* ***Materials:*** *Necdet İmaç.*

REFERENCES

1. Ahuja R, Jyoti B, Shewale V, Shetty S, Subudhi SK, Kaur M. Comparative evaluation of pediatric patients with mental retardation undergoing dental treatment under general anesthesia: a retrospective analysis. J Contemp Dent Pract. 2016;17(8):675-8. [Crossref] [PubMed]
2. Jaakkola S, Rautava P, Alanen P, Aromaa M, Pienihäkkinen K, Räihä H, et al. Dental fear: one single clinical question for measurement. Open Dent J. 2009;3:161-6. [Crossref] [PubMed] [PMC]
3. Guney SE, Araz C, Tirali RE, Cehreli SB. Dental anxiety and oral health-related quality of life in children following dental rehabilitation under general anesthesia or intravenous sedation: A prospective cross-sectional study. Niger J Clin Pract. 2018;21(10):1304-10. [PubMed]
4. Bennett JD, Kramer KJ, Bosack RC. How safe is deep sedation or general anesthesia while providing dental care? J Am Dent Assoc. 2015;146(9):705-8. [Crossref] [PubMed]
5. Wang YC, Lin IH, Huang CH, Fan SZ. Dental anesthesia for patients with special needs. Acta Anaesthesiol Taiwan. 2012;50(3):122-5. [Crossref] [PubMed]
6. Behavior Guidance for the Pediatric Dental Patient. Pediatr Dent. 2018;40(6):254-67. [PubMed]
7. Savanheimo N, Sundberg SA, Virtanen JI, Vehkalahti MM. Dental care and treatments provided under general anaesthesia in the Helsinki Public Dental Service. BMC Oral Health. 2012;12:45. [Crossref] [PubMed] [PMC]
8. Davidson AJ, Sun LS. Clinical evidence for any effect of anesthesia on the developing brain. Anesthesiology. 2018;128(4):840-53. [Crossref] [PubMed]
9. Messieha Z, Ananda RC, Hoffman I, Hoffman W. Five year outcomes study of dental rehabilitation conducted under general anesthesia for special needs patients. Anesth Prog. 2007;54(4):170-4. [Crossref] [PubMed] [PMC]
10. Fiorillo L. Conscious sedation in dentistry. Medicina (Kaunas). 2019;55(12):778. [Crossref] [PubMed] [PMC]
11. Rosenberg M; American Dental Association. New guidelines for the use and teaching of general anesthesia and sedation by dentists. J Mass Dent Soc. 2010;58(4):22-7. [PubMed]
12. Dougherty N. The dental patient with special needs: a review of indications for treatment under general anesthesia. Spec Care Dentist. 2009;29(1):17-20. [Crossref] [PubMed]
13. Lim MAWT, Borromeo GL. The use of general anesthesia to facilitate dental treatment in adult patients with special needs. J Dent Anesth Pain Med. 2017;17(2):91-103. [Crossref] [PubMed] [PMC]
14. Ohtawa Y, Tsujino K, Kubo S, Ikeda M. Dental treatment for patients with physical or mental disability under general anesthesia at Tokyo Dental College Suidobashi Hospital. Bull Tokyo Dent Coll. 2012;53(4):181-7. [Crossref] [PubMed]
15. Sitkin SI, Gasparian AL, Ivanova TI, Nesterova EI, Drozdova NI. [Long-term dental interventions in mentally retarded children under general anesthesia with sevoflurane]. Stomatologiia (Mosk). 2015;94(1):59-60. Russian. [Crossref] [PubMed]
16. Schnabl D, Guarda A, Guarda M, von Spreckelsen LMI, Riedmann M, Steiner R, et al. Dental treatment under general anesthesia in adults with special needs at the University Hospital of Dental Prosthetics and Restorative Dentistry of Innsbruck, Austria: a retrospective study of 12 years. Clin Oral Investig. 2019;23(11):4157-62. [Crossref] [PubMed]
17. Campbell RL, Shetty NS, Shetty KS, Pope HL, Campbell JR. Pediatric dental surgery under general anesthesia: uncooperative children. Anesth Prog. 2018;65(4):225-30. [Crossref] [PubMed] [PMC]
18. Miller R, Eriksson L, Fleisher L, Wiener-Kronish J, Young W. Miller's Anesthesia. 7th ed. Philadelphia: Churchill Livingstone/Elsevier; 2009.
19. Özkan AS, Erdoğan MA, Şanlı M, Kaçmaz O, Durmuş M, Çolak C. Retrospective evaluation of dental treatment under general anaesthesia. Turk J Anaesthesiol Reanim. 2015;43(5):332-6. [Crossref] [PubMed] [PMC]
20. Wheeler DS, Vaux KK, Ponaman ML, Poss BW. The safe and effective use of propofol sedation in children undergoing diagnostic and therapeutic procedures: experience in a pediatric ICU and a review of the literature. Pediatr Emerg Care. 2003;19(6):385-92. [Crossref] [PubMed]
21. Messieha Z, Cruz-Gonzalez W, Hakim MI. Retrospective outcomes evaluation of 100 parenteral moderate and deep sedations conducted in a general practice dental residency. Anesth Prog. 2008;55(4):116-20. [Crossref] [PubMed] [PMC]

22. Özmert S, Kavak Akelma F, Ökten ZC. Derin sedasyon altında dental tedavi uygulanan çocuklarda anestezik yaklaşımın değerlendirilmesi [Evaluation of the anesthetic approach in children for dental treatment under deep sedation]. Türkiye Çocuk Hast Derg/Turkish J Pediatr Dis. 2019;13(1):30-5. [Link]

23. Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's Clinical Anesthesiology. 6th ed. New York: McGraw Hill; 2018.

24. Mishu MP, Faisal MR, Macnamara A, Sabbah W, Peckham E, Newbronner L, et al. A Qualitative study exploring the barriers and facilitators for maintaining oral health and using dental service in people with severe mental illness: perspectives from service users and service providers. Int J Environ Res Public Health. 2022;19(7):4344. [Crossref] [PubMed] [PMC]

25. Chen GY, Wu ZF, Lin YT, Cheng KI, Huang YT, Huang ST, et al. Association between general anesthesia and root canal treatment outcomes in patients with mental disability: a retrospective cohort study. J Pers Med. 2022;12(2):213. [Crossref] [PubMed] [PMC]