Cost and Time Analysis of Procedural Sedation versus General Anesthesia in a Pediatric Dentistry Residency Program

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Abstract

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Purpose: The objectives of this study were to compare dental procedures, associated costs, and time required to provide pediatric dental treatment with procedural sedation (SED) and general anesthesia (GA).

Methods: This 2 year retrospective chart review of patients treated at the University of Washington Center for Pediatric Dentistry included a convenience sample of 50 patients who received SED and 50 patients who received GA. Costs were calculated based upon treatment time and Washington State Medicaid rates.

Results: On average, patients in the SED group were older, more likely to be female, and more frequently received intracoronal restorations than patients in the GA group. Combined dental treatment and modality costs were significantly lower for SED than GA ($690 vs. $2350). Inversely, the averaged time required to complete a treatment plan with SED was significantly greater than time required to complete a treatment plan under GA (250 vs. 173 minutes).

Conclusions: Costs associated with SED were significantly lower than GA. However, this was inversely related to time required to complete a treatment plan. In addition, fewer dental procedures were completed with SED. Sedation offers a cost-effective adjunct for children with limited treatment needs and temperament conducive to moderate sedation.

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DEDICATION

I would like to dedicate this to my fiancé, Garrett, and to my family for their endless support and unwavering confidence in me. Without you I would not be here.

To my co-residents, for an incredible two years. I could not be more grateful to have grown alongside and shared this unforgettable journey with you.

Chapter 1. INTRODUCTION

Children with restorative dental needs and uncooperative behavior pose a significant challenge for pediatric dentists. These patients often cannot cooperate due to lack of psychological or emotional maturity and/or having a mental, physical, or medical disability.[1] Pharmacologic management is frequently employed for patients who cannot be managed effectively using basic behavior guidance techniques.[2] Contemporary parental attitudes reflect an increasing acceptance of pharmacological behavior guidance modalities such as procedural sedation (SED) and general anesthesia (GA).[3,4] Factors influencing parental acceptance of advanced behavior guidance techniques include amount and types of treatment necessary, out-of-pocket costs, and the number of appointments required to complete treatment.[4]

The percentage of pediatric dentists practicing SED has decreased over time.[5] This is in large part due to the increasing prevalence of ambulatory anesthesia services and the use of dentist anesthesiologists.[6] However, both SED and GA techniques continue to be widely used in clinical practice and are taught by all post-doctoral pediatric dentistry programs.[7] When considering pharmacologic options, clinicians must take into account patient health status, treatment needs, behavior, and parent preferences. Cost to patients, providers, and third party payers is another factor that should be considered.[8] Over 15 years ago Lee et. al. found that if a dental treatment plan required more than three procedural sedation appointments GA was a less costly and more efficient option.[9] A more recent analysis using a cost minimization model suggested that in-office GA presents a cost savings over a hospital-based procedure.[11] In some situations there are clear indications to provide treatment with SED or GA. In many cases, however, either modality can be an effective option. Analyses of the types of dental treatment

performed, cost, and time required to complete treatment with SED and GA are needed to provide clarity regarding the strengths and limitations of these two treatment modalities.

The aims of this study were to evaluate pediatric patients who received SED or GA at a pediatric dentistry residency program to determine: (1) number and type of restorations completed; (2) modality and dental treatment costs; and (3) time required to complete dental treatment.

Chapter 2. METHODS

2.1 STUDY DESIGN AND SAMPLE

This study employed a two year retrospective study design. Following approval by the Human Subjects Division of the University of Washington's Institutional Review Board (STUDY00004679), we reviewed dental charts for SED and GA patients who met inclusion criteria. The sample was comprised of a convenience sample of 50 patients who received an identical oral sedation regimen of Midazolam (0.3 mg/kg), Meperidine (1.5 mg/kg), and Hydroxyzine (1.0 mg/kg) for restorative dental treatment, and 50 patients who received restorative dental treatment using in-office GA between January 2016 and December 2017. Patients between the ages of 24 and 71 months with ASA classification I or II health status enrolled in Washington State Medicaid insurance were eligible for inclusion. Self-pay or private insurance patients, patients outside of the selected age range, children with ASA III+ health status, those with Autism Spectrum Disorder and other developmental disabilities, patients who received an alternate sedation regimen, and children who did not receive restorative dental treatment (e.g. extractions or other surgical care only) were excluded from this study. Patients in the GA group were all treated under the supervision of the same attending faculty with anesthesia provided by a mobile MD anesthesiologist. This attending dental provider also supervised at least the initial sedation for each patient in the SED group.

2.2 DATA COLLECTION

The predictor of interest was treatment with SED versus treatment with GA. The outcomes of interest are as follows: (1) number and type of dental restorations completed during each visit; (2) costs for dental procedures and pharmacologic modality for each visit; and (3) time required

to complete treatment for each visit and number of visits per patient if more than one visit was required.

Current Dental Terminology (CDT) codes, were collected for all completed procedures. Number and type of restorations were quantified using CDT codes billed at each visit. The following categories of dental procedures were established: stainless steel crown (SSC), intracoronal restoration (ICR), anterior esthetic restoration (AEC), extraction, sealants, pulp treatment, space maintainer, and other. These codes were also used to calculate cost based upon the Washington State Medicaid Access to Baby and Child Dentistry (ABCD) reimbursement rates. Fees for diagnostic and preventive services (examination, radiographs, prophylaxis, and fluoride) were excluded.

Data for pharmacologic modality cost models were also based upon CDT codes. Codes D9230 (nitrous oxide analgesia/visit), D9248 (non IV conscious moderate sedation), and D9920 (behavior management) were billed out for each SED visit. For the cost of GA, D9222 (deep sedation/general anesthesia - first 15 minutes) was used for the initial 15 minute increment of time, and D9223 (deep sedation/general anesthesia – each subsequent 15 minute increment) for every 15 minute increment thereafter. It is important to note that costs were estimated based upon fees for the procedures that that were billed out, not what was ultimately reimbursed by Medicaid. Dental treatment and pharmocologic modality costs were calculated both individually and as a sum to generate total cost. For SED patients who required more than one visit to complete a treatment plan, dental cost and SED costs were calculated separately for each visit as well as for the cumulative number of visits required to complete treatment. All treatment plans for GA patients were completed in a single visit.

The following time points were obtained from patient records and used to calculate SED time measurements: check-in, administration of sedation medications, monitor placement, treatment complete, and dismissal times. For GA time measurements, the following times were extracted: check-in, throatpack in, throatpack out, and dismissal times. Time distribution measurements were then divided into the following categories: (1) pre-operative time—defined as check-in to treatment start time, including a latent period experienced by SED patients following medication administration; (2) treatment time—defined as monitor placement to treatment complete time for SED, throatpack in to throatpack time out for GA; (3) post-operative observation period—defined as treatment complete to dismissal time for SED and GA; and (4) total time—defined as check-in to dismissal times for SED and GA.

Procedural sedation success and failure rates were evaluated using the Houpt Behavior Rating Scale (HBRS). A successful sedation was defined as a score of excellent, very good, or good. A fair, poor, or aborted result was considered to be a sedation failure.

2.3 DATA ANALYSIS

All extracted data was collected into an Excel document and imported into Stata 15.1 for analysis. Descriptive statistics (means, standard deviations (SD), counts, and percentages) were calculated for all variables. Associations between treatment modality and all categorical variables were evaluated using Chi-square or Fisher's Exact tests. Associations between treatment modality and all continuous variables (time and cost) were tested using a 2 sample t-test with unequal variances. The critical value was set at 0.05.

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Chapter 3. RESULTS

The majority of the participants were female (51%), older than 48 months (69%), and had ASA I classification (90%) (Table 1). Children treated with SED were significantly more likely to be female than children treated with GA (60% vs 38%, $P < 0.028$). There were a significantly higher number of children 48 months or younger in the GA group compared to the SED group (52% vs 10%, $P < 0.001$). There was not a statistically significant difference in health status of patients in the SED and GA groups (Table 1).

There was a total of 74 sedation visits performed for the 50 SED patients. The number of visits ranged from one to four with 62% having his or her treatment completed with one visit and 34% with two visits. Additionally, one patient (2%) required three visits and one patient (2%) required four visits. The overall SED success rate for the sedation visits was 66% (Data not shown). There was a significant difference in success rate of SED by number of visits required with the highest success rate (74%) at the second visit ($P = 0.011$) (Figure 1).

3.1 DENTAL PROCEDURES

There was a significant association between restoration type and treatment modality ($P < 0.001$) (Figure 2). ICR was the only treatment type that was more frequently performed with SED than GA (50% vs 21%). All other dental procedures were provided more often under GA, with AEC being completed almost exclusively under GA (17% vs 4%). Stainless steel crowns were placed more commonly under GA as compared with SED (39% vs. 29%) (Figure 2).

3.2 COST

Patients receiving treatment under GA had significantly higher pharmacologic modality fees, dental procedures, and overall costs than those who received treatment with SED ($P < 0.001$ for

all) (Table 2). The mean modality related cost per visit was $653 for GA and $137 for SED. Total charges, including modality cost and dental procedure fees, were significantly different between the two groups. Mean total charges were $2,352 for GA versus $686 for SED (P<0.001). Patients undergoing GA received a greater number of dental procedures, and consequently fees related to dental procedures were much greater in the GA group. An average of 4 procedures were performed for each patient when only the initial SED visit was considered. However, when all SED visits were analyzed each patient received an average of 6 procedures . Patients had an average of 13 procedures performed under GA (P < 0.001). Two of the patients in the SED group did not receive any dental treatment due to behavioral challenges. An additional four patients had at least one SED visit wherein no dental treatment was rendered. The average cost per dental procedure for a patient receiving SED was $104 compared to $131 for a patient receiving GA (P < 0.001) (Table 2).

3.3 TIME

The mean pre-op time for a single SED visit was 99 minutes (Table 3). However when looking per person (i.e. accounting for all SED visits required to complete treatment), the pre-op time increased to 143 minutes and was significantly greater than the mean pre-op time (52 minutes) in a GA patient (P < 0.001).

The mean treatment time for a single SED visit was 53 minutes. However when looking per person, the treatment time increased to 76 minutes. This was not significantly different than the mean treatment time (89 minutes) in a GA patient (P = 0.096). While the average treatment time for GA was only slightly greater when compared with SED visits, it is worth noting that the average number of procedures completed during a GA appointment was more than double that of sedation.

The mean total time required for a single SED visit was 173 minutes. Patients with 2 and 3 SED visits had 353 and 542 min total time respectively. The mean total time for SED increased by approximately 30 minutes for the fourth SED visit. The overall mean time required to complete a treatment plan with SED was 250 minutes vs. 174 minutes in a GA patient ($P < 0.001$) (Table 3).

Chapter 4. DISCUSSION

SED and GA are important means of providing patient comfort and safety during invasive and/or uncomfortable dental procedures. In this study, we evaluated a sample of healthy children receiving dental care with SED or GA at a pediatric dental residency program. Our first aim was to determine the number and types of restorations completed using each of the two pharmacologic modalities. Children treated under GA received a greater number and variety of dental procedures than children who received SED, with GA patients receiving over 2 times as many procedures per visit as sedation patients. AEC were performed almost exclusively during GA treatment, and SSC were placed more frequently under GA than SED (Figure 2). Procedures such as AEC, pulpotomies and puplectomies can be challenging and may be performed more frequently with GA when patient behavior is not a factor. In addition, half of all dental procedures provided with SED were intracoronal restorations while extractions and stainless steel crowns were more common under GA. This may reflect a treatment philosophy of providing definitive treatment in this high-risk population. The baseline level of disease may have also been higher in the GA population, leading to a greater number and complexity of procedures performed.

Our second aim was to determine cost associated with each pharmacologic modality and the overall cost of the treatment modality and dental treatment. The modality related fees for GA were significantly higher than those associated with SED. This is reflective of the fact that reimbursement rates must take into account the cost of having a dedicated anesthesia provider present when administering GA. In 2001 Lee et. al used a relative value unit (RVU) system to compare SED and hospital-based GA costs.[9] That study assumed that the same treatment could be rendered with each modality, and that all patients would be appropriate candidates for SED.

Theoretical costs where then calculated with each patient serving as his or her own control. They determined that cost for GA may be less when three or more SED visits would be required to complete treatment. Using a similar study model, Green et. al. found that hospital-based GA was less cost effective and that in-office GA proved more cost effective for children requiring more than four SED visits to complete treatment.[11] These analyses factored in opportunity costs such as lost wages from caregivers missing work, missed school days, additional physician visits, travel expenses, and associated stresses. They also used dental RVU's to compare dental treatments.

We did not account for opportunity cost to the family in our assessment, and actual treatment data was used for our SED group analysis as opposed to each patient serving as his or her own control. At current Washington state Medicaid reimbursement rates, a patient in the present study could potentially have 4.7 SED visits for the cost of the GA appointment. While study methodologies differ, ultimately this finding is in line with what others have reported. Importantly, this calculation does not account for a patient's individual treatment needs, temperament, and the cumulative risk of multiple sedation visits.

Costs related to dental procedures alone were much higher for GA, both per procedure and collectively. This is based upon the fact that patients undergoing GA received significantly more treatment when compared with the average patient who received SED. This may be in part because patient behavior is not a factor when treatment in provided under GA working time is limited when using oral medications, and maximum local anesthetic doses are limited in young children. Another possible explanation is that at this study site cases with larger treatment plans were scheduled for GA. Providers may also opt for more definitive, and often consequently more costly, treatment under GA due to younger patient age and higher caries risk. Dental treatment

rendered under GA may be more effective, potentially resulting in reduced future dental treatment needs.[15]

Our third aim was to compare the time required to complete treatment with SED and GA. The time the SED group spent in the pre-op phase was much greater than that experienced by GA patients. A greater pre-op time is inherent for SED patients due to the latent period experienced after sedative medication administration. Treatment plans for most of the patients in the SED group were completed within one or two visits, with the majority receiving all treatment in a single visit. It is interesting to note that the total time required to complete treatment with GA was nearly equivalent to the duration of a single SED visit. For patients with two or more SED visits, total time increased by approximately 3 hours for every appointment. Because the average number of procedures completed with GA was more than twice that of sedation, it represents a more efficient treatment modality. This becomes particularly apparent for patients with large treatment plans requiring more than one sedation visit.

It is also important to note that the patients in our SED sample experienced a significant treatment failure rate. Approximately 30% of patients who presented for a single visit, and 20-25% of patients who came for a second visit had fair, poor, or aborted sedations. Although success rates did improve from first sedation visit to a second sedation visit, there was still a significant risk that children would have a behavioral failure. Thus, while potentially less costly it must be noted that SED is also less predictable. A patient may experience a SED visit where only limited treatment is accomplished or the procedure is aborted, possibly necessitating that treatment be completed under GA. The fee for the failed sedation is then added to the GA fee, increasing the overall cost to complete care. In this scenario the dental practice also experiences a loss of production when treatment is not rendered during the initial sedation visit and the

family experiences an opportunity cost related to missed school and work. Therefore, the risks of multiple sedation procedures and the financial cost to the patient and practice must be considered carefully.

Surveys indicate that approaches to managing pediatric dental caries are changing.[16] Three decades ago it was common for pediatric dentists to sedate children under age 3 for dental treatment. Today the average age of children who receive procedural sedation for dental care is older.[5] Minimally invasive treatment options (e.g. silver diamine fluoride, interim therapeutic restorations, Hall crowns) can often be employed to delay treatment for the youngest patients or pediatric dental providers may work with dedicated anesthesia providers to render definitive treatment.

Based upon these findings, it appears that SED in a pediatric dentistry residency program is a cost-effective treatment modality for children with smaller treatment plans and temperament conducive to moderate sedation. While not included in the present study, SED is also an affordable way to manage brief invasive procedures such as extractions. On the other hand, GA predictably allows for completion of a full treatment plan in a single visit. This is beneficial for young children who have greater, more complex care needs or difficult temperament. In these situations, GA also results a significant time savings to the family and the dental practice.

4.1 LIMITATIONS AND FUTURE RESEARCH

This study had a number of strengths. While other cost-analysis studies have focused on a hypothetical model that extrapolates cost to the various treatment modalities, the present study used actual patient treatment data. All GA treatment and at least the initial sedation appointment was supervised by the same attending faculty. Thus, differences in treatment planning philosophy likely had a minimal effect on our results. Using this model, we were also able to

take into account the relatively large number of failed sedations. This is a practice reality that must be considered when deciding between pharmacologic treatment modalities.

This study was also subject to a number of limitations. A higher percentage of females received SED in our study. It is possible that this finding reflects parent or providerbias, with males being selected for GA more frequently due to perceived impulsivity or lower likelihood of experiencing successful sedation. It is also possible that this finding may simply be due to the small sample size of this study and its retrospective observational design. Randomized controlled trials with larger study groups are needed to provide more accuracy and reliability.

While the utilization of office-based GA and ambulatory surgery centers is growing in popularity among pediatric dentists, many maintain operating room privileges at hospitals to treat some or all of their patients. This study did not assess dental treatment completed under GA in a hospital based setting. This is a limitation of our study and an opportunity for future research. This study was also limited by the insurance status of the patients in our sample. Only patients with Medicaid were included for consistency and accuracy in comparing costs. Fees are commonly determined by insurance companies, and out of pockets costs can differ for those with private insurance as well as for self-pay patients. Furthermore, WA Medicaid reimbursement is among the lowest in the nation and these fees are not necessarily representative of other states. Our analysis of time per procedure is a coarse measurement, with more complicated treatment like an AEC obviously being more involved than a simple procedure such as a sealant. Use of RVU’s or another accounting mechanism would have more accurately accounted for this, however that was not the primary purpose of this study. The numbers here are presented to provide a broad picture of the volume of treatment rendered under each modality in a residency

program. Times and number of restorations are likely not representative of those provided in private practice settings.

Similarly, we used a multi-agent narcotic sedation regimen. The latent period and the post-operative observation time may be longer with this combination of medications than when performing single-agent sedation. Use of alternate medications may have resulted in shorter SED visits.

Chapter 5. CONCLUSION

Based on this study's results, the following conclusions can be made:

1. The mean modality cost-per-visit was significantly greater for GA than SED.

2. Patients who were treated with GA received a greater number and complexity of dental procedures than those who had SED. As a result, total charges were significantly greater for the GA group.

3. Mean time for a single visit was similar for SED and GA. When more than one SED visit was required to complete treatment, treatment time increased by approximately 3 hours per additional visit.

4. SED success was variable, with 20-30% of visits resulting in fair, poor, or aborted sedation. Treatment plans were always completed with a single GA visit.

5.1 CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

Table 1: Patient Demographic Variables

	Overall	**General Anesthesia**	**Procedural Sedation**	
	N = 100	N = 50	N = 50	
	N (%)	N (%)	N (%)	p-value*
Gender				**0.028**
Female	49 (49.0%)	19 (38.0%)	30 (60.0%)	
Male	51 (51.0%)	31 (62.0%)	20 (40.0%)	
Age at First Visit (months)				**<0.001**
<= 48 months	31 (31.0%)	26 (52.0%)	5 (10.0%)	
> 48 months	69 (69.0%)	24 (48.0%)	45 (90.0%)	
ASA				0.182
I	90 (90.0%)	43 (86.0%)	47 (94.0%)	
II	10 (10.0%)	7 (14.0%)	3 (6.0%)	

*Calculated using a Chi-square test

Table 2: Cost and Amount of Treatment Performed with Procedural Sedation and GA

	Pharmacologic Modality Type		
	General Anesthesia	**Procedural Sedation**	
	N = 50	N = 50	
Cost ($)	Mean (SD)	Mean (SD)	p-value*
PER PERSON			
Pharmacologic Modality Cost	653.64 (145.19)	137.34 (52.44)	**<0.001**
Dental Procedures Cost	1,698.90 (722.63)	571.83 (431.83)	**<0.001**
Total	2,352.54 (836.79)	686.30 (476.01)	**<0.001**
	N = 50	N = 48	
Number of Procedures (N)	12.76 (4.01)	5.58 (3.23)	**<0.001**
Cost per Procedure ($)	131.08 (32.20)	104.36 (36.76)	**<0.001**
PER VISIT	N = 50	N = 68	
Number of Procedures (N)	--	4.06 (1.79)	--**
Cost per Procedure ($)	--	106.30 (36.06)	--**

SD= Standard Deviation
*Calculated using a 2-sample t-test with unequal variances
**All participants had one visit for GA, comparisons tested for per person data.

Table 3: Time for Treatment Provided with Procedural Sedation and GA

	Pharmacologic Modality		
	General Anesthesia	**Procedural Sedation**	
Time (minutes)	Mean (SD)	Mean (SD)	p-value*
PER VISIT	N = 50	N = 74	
Pre-Operative Wait Time	51.54 (27.99)	98.55 (24.34)	**<0.001**
Treatment Time	88.54 (27.31)	52.85 (18.33)	**<0.001**
Total	173.52 (46.15)	172.99 (28.24)	0.937
PER PERSON	N = 50	N = 50	
Pre-Operative Wait Time	51.54 (27.99)	142.50 (64.80)	**<0.001**
Treatment Time	88.54 (27.31)	75.82 (46.04)	0.096
Total	173.52 (46.15)	250.14 (112.61)	**<0.001**

SD= Standard Deviation
*Calculated using a 2-sample t-test with unequal variances

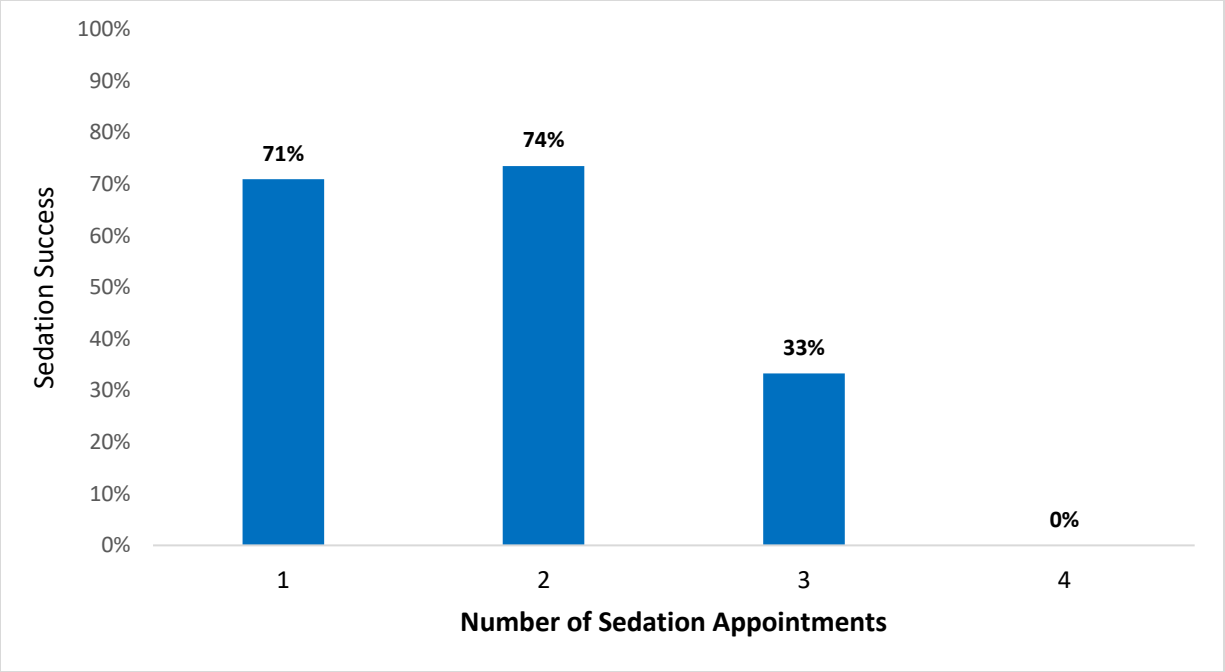

Figure 1: Procedural Sedation Success Rating (HBRS) by Number of Appointments. Sedation success is significantly associated with number of appointments (Fisher's Exact P = 0.01).

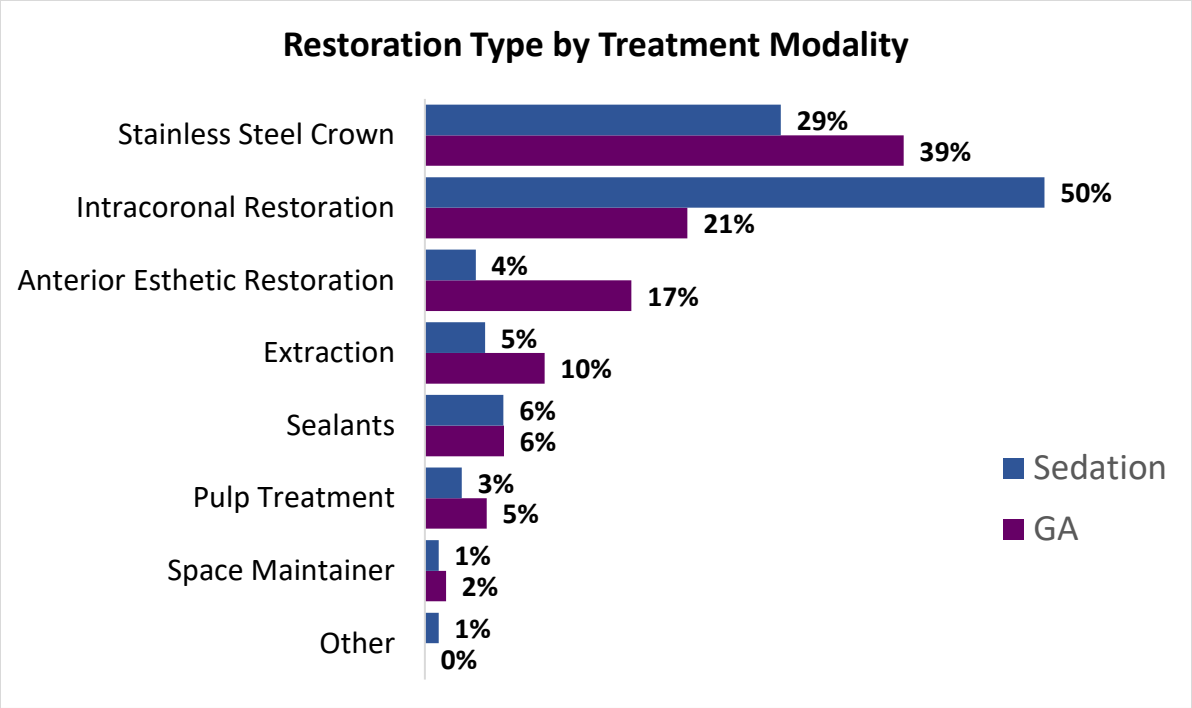

Figure 2: Types of Procedures Performed with Procedural Sedation and GA. Type of procedure and treatment modality are significantly associated (Fisher's Exact $P < 0.001$).

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