ORIGINAL ARTICLE

Clinical outcomes of different sedation techniques used in pediatric dentistry

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ABSTRACT

Background: Dental treatment procedures in childhood may trigger high levels of anxiety and fear. In these circumstances sedation protocols with different agents serve acceptable, safe and effective treatment environments. We aimed to investigate the better and safer sedation regimen being used in our institution.

Methodology: We retrospectively investigated medical and anesthesia reports of 553 children, who underwent dental treatments with different anesthetic agents. Total anesthesia time, intraoperative vital signs (heart rates, peripheral oxygen saturation and arterial blood pressure), perioperative complications including tachycardia, bradycardia, hypo/hypertension, respiratory depression, bronchospasm, nausea, vomiting, agitation and/or hallucinations were recorded. The results were analyzed by SPSS (version 20.0) using independent T-test, Wilcoxon, Mann-Whitney, and Pearson Chi-square tests as appropriated. Data are expressed as mean ± standard deviation or median (25%-75%), (minimum-maximum), or as n (%).

Results: The shortest anesthesia time was recorded with sevoflurane anesthesia while longest was recorded in ketamine IM + ketamine IV + midazolam IM + midazolam IV group (18.88 ± 9.45 versus 58.57 ± 17.73 minutes). There was no recorded side effect in 405 (73.2%) procedures while tachycardia in 114 (20.6%), hypotension or hypertension in 9 (1.6%), respiratory depression in 6 (1.15) patients and bradycardia in 5 (0.9%) patients were recorded. 4 patients (0.7%) were suffered from bronchospasm. Tachycardia was most common in ketamine IM + ketamine IV administered group (n=26, 22.8%). In contrast there was no recorded tachycardia in patients sevoflurane alone or propofol alone groups (0 patient in both groups). Postoperative nausea and vomiting rates were lowest in ketofol procedures. Postoperative agitation and hallucination rates were higher in ketofol bolus + ketofol infusion procedure (12.7%)

Conclusion: Sedation with different anesthetics either alone or combined during pediatric dentistry can be accepted as safe and comfortable for both patients and healthcare professionals. We suggest that less complication rates with ketofol regimens noted in this study needs to be investigated in more strongly designed future studies.

Keywords: Conscious Sedation; Moderate Sedation; Deep Sedation; Inhalation; Inhalation Administration; Anesthesia, Inhalation; Intravenous; Anesthetics, Intravenous;

Injections, Intravenous; Pediatric dentistry

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INTRODUCTION

Sedation in dentistry offers an excellent and perhaps the only way to provide safe, anxiety-free, dental experience to children afraid of dental procedures. Although different levels of sedation (mild, moderate and deep) can be selected depending on patients' anxiety level and general health status, deep sedation (amounting to unconsciousness is often the preferred sedation level for children. Several different agents – both inhalation and intravenous - are used in sedation procedures for children. Ketamine, midazolam, propofol, fentanyl, sevoflurane, alone or with combination, are the most common used anesthetic agents in this special population.[1-5] In this study we presented our clinical experience with using different anesthetic agents for sedation in children for dentistry.

METHODOLOGY

After obtaining approval of Ethics Committee of our institution we retrospectively investigated 553 medical records of patients who underwent different sedation protocols for dental treatments during 2011-2013. Patients case records which lacked data about pre-anesthesia examination, and intraoperative and postoperative anesthesia records were excluded from the study. Demographic data, age, body weight, ASA status, co-morbidities, total time of sedation, duration of dental treatment, vital signs include heart rate, peripheral oxygen saturation (SpO_2), blood pressure, intraoperative and postoperative side effects include tachycardia, bradycardia, hypo/hypertension, vomiting, respiratory depression, bronchospasm, postoperative agitation, hallucination were recorded.

Statistical Analysis: The results were analyzed by SPSS (version 20,0) using independent T-test, Wilcoxon, Mann-Whitney, and Pearson Chi-square tests as appropriated. Data were expressed as mean ± standard deviation or median (%25-%75), (Minimum-Maximum), n (%)].

RESULTS

Demographical data and ASA status are presented in Table 1. Anesthetic agents used and number of patients are presented in Table 2. One hundred and fifty eight patients (28,6%) were administered ketamine+propofol (ketofol), while sevoflurane was used in 134 patients (24.2%) and ketofol+midazolam was used in 76 patients (13.7%).

Table 1. Demographical data [Mean ± SD (Min-Max), n]

Parameter	n (553)
Age (year)	5.99 ± 2.53 (2-16)
Body weight (kg)	21.09 ± 8.21 (10-76)
Gender (M/F)	248/305
ASA(I/II/III)	375/171/7
Anesthesia time (min)	37.96 ± 19.14 (15-120)

Mean anesthesia time for different agents are presented in Table 3. Duration of anesthesia was between 15 and 120 min. The shortest anesthesia time was recorded with sevoflurane anesthesia, while longest was recorded in ketamine IM+ketamine IV+midazolam IM+ midazolam IV group (18.88 ± 9.45 versus 58,57 ± 17,73 minutes).

Side effects of anesthesia during perioperative period are recorded. There were no recorded side effects in 405 (73.2%) procedures while tachycardia in 114 (20.6%), hypotension or hypertension in 9 (1.6%), respiratory depression in 6 (1.15%) patients and bradycardia in 5 (0.9%) patients were recorded. Also bronchospasm and mild drug reactions were noted in 4 patients.

Table 2. Number and percentages of patients adjusted for anesthesic agents [n, (%)]

Anesthesia Technique	N (%)
Inhalation	134 (24.2)
Ketamine IM+ketamine IV	32 (5.8)
Ketamine IM+Dormicum IM+ketamine IV	60 (10.8)
Ketamine IV+Dormicum IV+ketamine IV	36 (6.5)
Propofol bolus+ maintenance	4 (0.7)
Ketofol bolus+maintenance	158 (28.6)
Ketofol+ dormicum	76 (13.7)
Ketamine + dormicum	19 (3.4)
Propofol bolus+maintenance +Dormicum 1mg IV+ Fentanyl 1mcg/kg IV	4 (0.7)
Ketamine IM+Dormicum IM+ketamine IV+ Dormicum 1mg IV	7 (1.3)
Propofol bolus+maintenance+ Dormicum 1mg IV	4 (0.7)
Inhalation+ Ketofol bolus+maintenance	7 (1.3)
Propofol bolus+maintenance+ Fentanyl 1mcg/kg IV	4 (0.7)
Inhalation+ Ketamine IV+Dormicum IV+ketamine IV	4 (0.7)
Inhalation+ Ketamine IM+Dormicum IM+ketamine IV	2 (0.4)
Ketamine IM+ketamine IV+ Dormicum 1mg IV	1 (0.2)
Ketamine IV+Dormicum IV+ketamine IV + Fentanyl 1mcg/kg IV	1 (0.2)

Table 3. Anesthesia time (min)

Anesthesia Technique	Mean ± SD (Min-Max)
Inhalation	18.88 ± 9.45 (15-60)
Ketamine IM+ketamine IV	32.66 ± 12.18 (15-60)
Ketamine IM+Dormicum IM+ketamine IV	48.17 ± 18.00 (15-90)
Ketamine IV+Dormicum IV+ketamine IV	43.75 ± 19.83 (15-90)
Propofol bolus+maintenance	45.00 ± 4.08 (40-50)
Ketofol bolus+ maintenance	43.48 ± 16.20 (15-105)
Ketofol+ dormicum	48.68 ± 17.80 (15-120)
Ketamine + dormicum	31.84 ± 10.70 (15-60)
Propofol bolus+ maintenance +Dormicum 1mg IV+ Fentanyl 1mcg/kg IV	47.50 ± 16.58 (25-60)
Ketamine IM+Dormicum IM+ketamine IV+ Dormicum 1mg IV	58.57 ± 17.73 (30-75)
Propofol bolus+ maintenance + Dormicum 1mg IV	31.25 ± 10.31 (20-45)
Inhalation+ Ketofol bolus+ maintenance	37.86 ± 15.24 (25-60)

Anesthesia Technique	Mean ± SD (Min-Max)
Propofol bolus+ maintenance + Fentanyl 1mcg/kg IV	38.75 ± 6.29 (30-45)
Inhalation+ Ketamine IV+Dormicum IV+ketamine IV	43.75 ± 2.50 (40-45)
Inhalation+ Ketamine IM+Dormicum IM+ketamine IV	47.50 ± 3.53 (45-50)
Ketamine IM+ketamine IV+ Dormicum 1mg IV	75
Ketamine IV+Dormicum IV+ketamine IV + Fentanyl 1mcg/kg IV	105

Table 4. Number and percentages of tachycardic patients perioperatively [n, (%)]

Anesthesia Technique	N(%)
Inhalation	0 (0)
Ketamine IM+ketamine IV	26 (22.8)
Ketamine IM+Dormicum IM+ketamine IV	22 (19.3)
Ketamine IV+Dormicum IV+ketamine IV	13 (11.4)
Propofol bolus+ maintenance	0 (0)
Ketofol bolus+ maintenance	14 (12.3)
Ketofol+ dormicum	15 (13.2)
Ketamine + dormicum	17 (14.9)
Propofol bolus+ maintenance +Dormicum 1mg IV+ Fentanyl 1mcg/kg IV	0 (0)
Ketamine IM+Dormicum IM+ketamine IV+ Dormicum 1mg IV	3 (2.6)
Propofol bolus+ maintenance + Dormicum 1mg IV	0 (0)
Inhalation+ Ketofol bolus+ maintenance	1 (0.9)
Propofol bolus+ maintenance + Fentanyl 1mcg/kg IV	0 (0)
Inhalation+ Ketamine IV+Dormicum IV+ketamine IV	1 (0.9)
Inhalation+ Ketamine IM+Dormicum IM+ketamine IV	2 (1.8)
Ketamine IM+ketamine IV+ Dormicum 1mg IV	0 (0)
Ketamine IV+Dormicum IV+ketamine IV + Fentanyl 1mcg/kg IV	0 (0)

Perioperative tachycardia rates in different agents are presented in Table 4. Tachycardia was most common in ketamine IM + ketamine IV administered group (n=26, 22.8%). In contrast there was no recorded tachycardia in patients in sevoflurane alone or propofol alone groups.

Side effects at postoperative period were recorded. Postoperative nausea was recorded in 176 (31.8%), vomiting in 172 (31.1%), agitation in 25 (4.5%) and hallucination in 7 (1.3%) patients. Postoperative nausea incidence was lowest in ketofol group. Similarly, the incidence of postoperative vomiting was found at lowest rates in ketofol group. Postoperative agitation rates were higher in ketofol bolus + ketofol infusion procedure (12.7%). Also postoperative hallucination rates were higher in ketofol bolus +ketofol infusion group as compred to all other groups (3.2%).

DISCUSSION

Dental treatment in childhood often causes undesirable and disturbing memories with agitation and fear. Many studies investigating childhood period report different dental anxiety ratios between 3% and 43% worldwide.[6] As a result sedation and analgesia have commonly become an important part of dental treatment in this population. Large number of clinical studies indicated effective and safe sedation levels with combination of different agents, rather than alone, in dental procedures.[1-9] Several studies have recently demonstrated that the combination of ketamine and propofol for procedural sedation and analgesia is safe and effective.[10-12] Shah et al[13] demonstrated less perioperative complications including agitation, prolonged recovery period with nausea and vomiting with propofol ketamine combination compared to ketamine alone. Similarly in our study we found higher nausea and vomiting rates with ketamine alone compared with ketofol group. We observed significantly less nausea and vomiting rates with ketofol regimen. However, postoperative agitation and hallucination rates were higher in ketofol bolus + ketofol infusion group.

Bad childhood memories associated with dental treatment may affect patients' future emotional reactions related with dentistry. So making efforts in order to limit this kind of negative memories is crucial. Midazolam is one of the best choice in this manner. Anterograde amnesia caused by midazolam is a well-known and effective feature of this agent.[3,14] As in ketamine and propofol combination; ketamine plus midazolam is commonly preferred regimen. A lower incidence of complications and recovery difficulties were reported with ketamine plus midazolam combination compared with ketamine alone.[15] Also fentanyl midazolam combination was found as effective as ketamine midazolam combination in a prospective study comparing sedation and recovery complications. Authors concluded that both regimens are equally effective and safe until the 20th minute of the dental procedures.[16]

Inhalation anesthesia/sedation for dental treatment has been preferred for many years. Before the extensive usage of sevoflurane, N_2O was commonly used for inhalation sedation. N_2O has low level potency with a minimum alveolar concentration of 110 vol%.[17] Especially in children this low potency produces an insufficient sedation level and mandates use of other sedative and analgesic drugs.[18] Sevoflurane is the most commonly used anesthetic agent in combination with N_2O with fast onset of action and high potency (55 times of that N_2O) and comparable recovery

times with N_2O.[19] Tolerance by children for sevoflurane is high and it can be safe and comfortably administered via face mask or any other device. Low concentrations of sevoflurane can be safe and satisfactory in combination with N_2O in children. In our study none of the children in inhalation (sevoflurane plus N_2O) group had tachycardia, vomiting and agitation. Nausea and hallucination rates were also minimal in this group.

LIMITATIONS

Our study has several limitations, such as its retrospective, uncontrolled, unequally grouped study design that restricts making clear comparisons between treatment regimens. Although these limitations are important factors for a clinical investigation, the study might be accepted as a report of different sedation regimens used in a large number of children for dental treatment in a clinic and only in this way the results may reflect clinical significance. Furthermore, no complication was recorded in 405 out of 553 (73.2%) children and all the complications were managed successfully without any harmful effect for patients.

CONCLUSION

In summary we can conclude that deep sedation protocols with different anesthetic agents –inhalation (alone or in combination with intravenous agents) or intravenous agents (alone or combined with others) are safe and effective for managing anxious pediatric dental patients. Use of ketamine is, however, associated with increased incidence of tachycardia, postoperative nausea and hallucinations.

Conflict of interest: None declared by the authors.

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