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Propofol intravenous conscious sedation for anxious children in a specialist paediatric dentistry unit

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Summary. *Objectives*. To report on both the use and dosage of propofol, as a new intravenous (IV) conscious sedative agent, for anxious children referred to a specialist paediatric dentistry service.

Setting. Paediatric Dentistry Unit, Glasgow Dental Hospital and School.

Sample. Thirty-four children, 25 females and 9 males, mean age 12 years 10 months, with a mean weight of 54·6 kg (range 30–110 kg).

Methods. Report from 34 patients receiving intravenous sedation for the first time in respect of weight dose and amount of treatment completed.

Results. Thirty-two children successfully accepted operative dental care on their first visit, they received a mean total dose of 146·25 mg of propofol (range 10 mg to 356 mg); in relation to body weight, the mean was 2·5 mg/kg (range 0·2–5·4 mg/kg). The treatment that they received included fissure sealants, amalgam and adhesive restorations, root canal therapy and single and multiple extractions. Their sedation and recovery were uneventful.

Conclusions. Sub-anaesthetic doses of propofol used for IV conscious sedation infusion facilitated operative dental treatment in anxious children.

Introduction

The most common reason for referral to new patient paediatric dentistry consultant clinics is the management of dental anxiety [1,2]. Not only are there risks associated with dental extractions under general anaesthesia but this can also contribute to dental anxiety in later life [3].

As many as 60% of anxious children can be treated by careful treatment planning and the use of behavioural management [4] while others require augmentation by conscious sedation. Nitrous oxide inhalation sedation (IS) is the mainstay of conscious sedation management for children's dentistry. Indeed, the technique is well documented [5,6] and numerous studies have proven both its immediate and long term benefits in children with mild to moderate anxiety to enable them to better accept dental treatment and to facilitate coping across sequential visits [7–16].

However, IS is less efficacious when used on severely anxious children [17] and prolonged, or multiple short exposure to nitrous oxide can result in depression of vitamin B12 activity. Dental surgeons, in particular, have been found to be most at risk. This risk is attributed to repeated exposure to high concentrations of nitrous oxide whilst working close to the nose-piece in the confined space of the dental surgery [18–24].

Midazolam has a rapid onset and a duration of action of about 30 minutes during which time sedation levels cannot routinely be reduced. Amnesia can be marked and can extend into the recovery period [25–28] but it does benefit from the availability of a reversal agent. It has been reported however that

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Midazolam causes hallucinations in children [29] and the amnesic effect might be less beneficial in anxious children for whom it is hoped that their acceptance of restorative dental treatment is sufficiently pleasant and memorable to allow future acceptance of routine dental care for the rest of their lives.

Propofol (Diprivan: 2,6 di-isopropophenol) an intravenous anaesthetic induction agent, when used in that setting causes a rapid loss of consciousness, loss of airway tone and reflexes, with cardiovascular and respiratory depression. However, used in sub anaesthetic concentrations, is a smooth fast-acting sedative with a very rapid induction and recovery. Subjects report sedation with propofol as a pleasant experience, although pain at the site of infusion is a common issue. The rapid onset and recovery from propofol sedation allows the sedation level to be varied during the period of treatment, e.g. higher levels of sedation during local anaesthesia injections or tooth extractions after which much lower levels of sedation can be used. Infusion of propofol by target-controlled infusion (TCI) or patient controlled infusion systems have already been reported to be effective in achieving conscious sedation not only for anxious adults presenting for dental surgery but also for those with learning disability [30–37]. Veerkamp *et al*. (1997) published an account of an exploratory study where children, mainly with nursing bottle caries, had teeth removed facilitated by propofol administered by an anaesthetist [38]. There are as yet few other published studies to support the use of propofol as a conscious sedative agent in children and none where the level of sedation is expected to comply with the General Dental Council definition [39]. Indeed, the efficacy of this drug as a conscious sedative agent has not been fully demonstrated for children and as such it is licensed for the induction and maintenance of general anaesthesia in children aged 1 month and over only [40].

Whilst intravenous sedation for paediatric dentistry is not generally recommended for routine use in primary care facilities [41], a specialist paediatric dentistry hospital service accepts referrals for primary and secondary care and as such treats some of the most anxious children, many of whom have failed to accept treatment elsewhere.

The specialist paediatric dentistry service in Glasgow Dental Hospital and School provides a pathway of care for referred anxious adolescents. This includes a series of acclimatization and prevention sessions, culminating in a reassessment of each child's anxiety and determination of the need for conscious sedation on a dedicated sedation assessment clinic. At the sedation assessment clinic their treatment is discussed, often facilitated by a tour of the sedation suite, an orthodontic opinion is obtained whenever appropriate, information sheets are supplied, informed consent obtained and EMLA cream prescribed. The specialist paediatric dentistry IV sedation service is led by a consultant in paediatric dentistry (MTH) and a consultant anaesthetist (AM) supported by a staff nurse with extensive anaesthetic experience and 2 dental nurses. There is a parallel general anaesthetic service led by a second consultant anaesthetist within hailing distance. The conscious sedation service is compliant with contemporary guidelines [39,41–43]. The parent is invited to be present throughout the IV dental visit, which normally lasts no longer that one hour, during which time the proposed treatment and consent is reaffirmed, venous access obtained and the dental treatment performed. The children are encouraged to bring along their favourite music, so that everyone can listen to it during the visit. No mouth props are used. Each patient is recovered in the dental chair before being escorted to a separate recovery area where they remain for a further 15 min. At the first IV sedation visit relatively simple treatment is performed, usually limited to one quadrant. On this service, propofol has been used almost exclusively as the single conscious sedative agent of choice over the last 3 years. Each child is treated in the morning after having been fasted from the night before.

The aim of this study was to report on the use of propofol as an intravenous (IV) conscious sedative infusion agent in anxious children who had been referred to a dental-hospital-based paediatric dentistry service.

Method

This study involved a review of 34 anxious ASA1 children (under 16 years of age), referred to a dental-hospital-based paediatric dentistry service who underwent dental treatment using propofol IV sedation between January 1999 and December 2001.

From a total of 34 cases, treatment under propofol intravenous sedation was aborted in 2 cases, one because the child refused cannulation, the second

Table 1. Calculation of units of treatment performed.

Units	Treatment performed
1	Extraction
2	Fissure seal, occlusal amalgam, preventive resin restoration (unlined)
3	Proximo-occlusal amalgam, preventive resin restoration (lined), mesial/distal composite resin restoration, pulpotomy, replacement of calcium hydroxide in root canal
4	Stainless steel crown, multisurface amalgam, composite resin strip crown, incisal corner composite resin restoration

because they refused to accept treatment whilst sedated and were subsequently referred for a general anaesthetic at a paediatric dentistry day surgery unit. Data from the remaining 32 children presenting for their first visit for treatment under IV sedation using propofol will be reported in this retrospective review. Each appointment included intravenous cannulation, induction of conscious sedation using propofol and the placement of a pulse oximeter. TCI sedation was commenced at a low level, e.g. 0·3 micrograms/mL and gradually increased by 0·2 microgram/mL steps, aiming for a deeper level of conscious sedation to allow local anaesthesia to be given without untoward effect. After local anaesthesia was established and dental treatment commenced the TCI level was reduced to 1·0 microgram/mL or lower, this lower level of conscious sedation was sufficient to allay anxiety with good local anaesthesia *in situ* and also reduce amnesia to a minimum to allow patients to recall successfully tolerating their treatment. This lack of amnesia appears to be very useful in increasing patient's confidence with successive visits. Each child remained conscious throughout and was instructed to give a hand signal if they wished the treatment to stop at any time for whatever reason, as part of our normal behavioural management regimen. Three of the subjects used a patient-controlled delivery system in which they were given a hand-held device with a button and were invited to press the button whenever they felt anxious, which would trigger the administration of 10 mg of propofol via the intravenous canulla, after which further demands would be unsuccessful for 30 seconds. Each child received at least one local anaesthetic injection preceded by benzocaine topical anaesthetic. The treatment was recorded and weighted according to that previously reported by Stephen *et al*. (1993) [37] as shown in Table 1.

The age of each child was noted together with the weight, total dose of propofol and treatment. The data was coded to ensure anonymity throughout.

Results

Thirty-two children, 25 females and seven males, mean age 13 years (range, 9–16 years) had all been referred because of their anxiety and high caries rate. Other treatment had been attempted prior to referral to the paediatric sedation service. Indeed, they had previously attended for a mean number of five visits, range 1–27 visits. The previous treatment included nitrous oxide inhalation sedation, behavioural management and hypnotherapy. Some had been referred to avoid a repeat general anaesthesic.

The children had a mean weight of 54·6 kg (range 30–110 kg) and received a titrated mean total dose of 146·25 mg of propofol (range 30 mg to 356 mg); in relation to body weight the mean was 2·5 mg/kg (range 0·2–5·4 mg/kg). The mean target blood level set using the target-controlled infuser was 1·4 micrograms/mL (range 0·3 micrograms/mL to 3·0 micrograms/mL) of propofol. The three children who used a patient-controlled sedation system received a total dose of 90 mg, 155 mg and 340 mg of propofol, respectively.

The lowest recorded Oxygen saturation (PSO_2) for each child is shown in Fig. 1. The lowest recorded PSO_2 overall was 92 but this was corrected when the finger probe was repositioned. None of the sedated subjects lost consciousness and each recovered uneventfully.

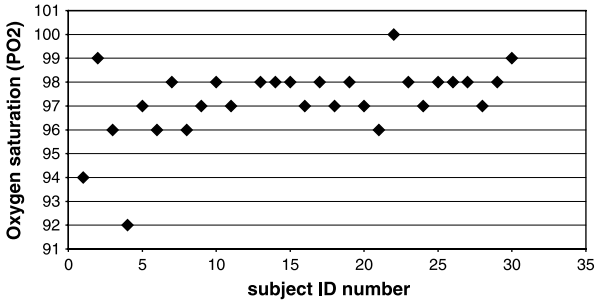

Fig. 1. Lowest recorded oxygen saturation per subject.

Table 2. Dental treatment provided.

Patient	Dental treatment	Number of quadrants
1	4 permanent dentition fillings	1
2	5 permanent dentition fillings	1
3	Surgical removal of permanent molar roots	1
4	1 permanent dentition filling	1
5	3 permanent dentition filling	1
6	1 permanent dentition filling	1
7	1 permanent dentition filling	1
8	Root canal therapy: permanent incisor	incisor
9	2 permanent dentition fillings	1
10	2 permanent dentition fillings including a direct composite crown	incisors
11	Orthodontic extraction: 4 first premolars	4
12	2 permanent dentition fillings	1
13	2 permanent dentition fillings, including a direct composite crown	incisors
14	3 permanent dentition fillings	2
15	2 permanent dentition fillings & extraction of a permanent molar	2
16	3 anterior permanent incisor multisurface composite restorations	incisors
17	2 permanent dentition fillings and 1 primary molar extraction	1
18	1 permanent dentition filling	1
19	5 permanent dentition fillings	2
20	Root canal therapy: permanent incisor	incisors
21	Extraction first permanent molar	1
22	Extraction first permanent molar	1
23	Scaling	1
24	1 permanent dentition filling: multisurface composite restoration	1
25	Root canal therapy: permanent incisor	incisors
26	2 permanent dentition fillings, included direct pulp caps	1
27	2 permanent dentition fillings	1
28	2 permanent dentition fillings	1
29	Fissure sealant	1
30	1 permanent dentition filling; included direct pulp cap	1
31	1 permanent dentition filling and 1 extraction of a permanent molar	1
32	3 permanent dentition fillings	incisors

The treatment performed was mainly restorative in nature but also included single and multiple extractions and root canal therapy. This is detailed in Table 2. The mean number of treatment units was 5·5 units, range 1–16 units. There was no correlation between the dose/kg and the treatment units performed, Pearson's correlation coefficient $R = 0{\cdot}15$.

It is noteworthy that most children complained of pain at the infusion site, this was usually relieved by 1 mL of 1% IV lignocaine, which was repeated if required. Moreover, propofol appears to raise the libido; some children innocently professed their attraction to a pop star ('I love … 911'), a schoolmate, or even a member of our team.

Discussion

The age and past dental history of this sample of children reflects the referral pattern of anxious healthy children to our department. The pathway of care that has subsequently been developed to include a more formal pre-sedation assessment to reduce wasted treatment visits is supported by the availability of other alternative means of facilitating dental treatment such as behavioural management and inhalation sedation. There is a local protocol excluding children over 10 years old from dental GA extraction services and a burgeoning day surgery GA waiting list at the local Children's Hospital. Therefore, healthy ASA1 children who are deemed too anxious to accept treatment under IS are instead referred for IV sedation. The fact that more females were treated compared to males is in keeping with other sedation studies that tend to reflect an increased anxiety in females.

The target concentration of propofol using the target controlled infusion system, and the final total dose irrespective of the delivery method, was less than in previous reports [44–46] and may be the reason why no child lost consciousness. The

anaesthetist varied the infusion rate depending on the procedure and level of observed anxiety for those children using the TCI system. No mouth props or any form of restraint was used and each child not only responded to verbal commands but was also often urged to 'open wider' and to use a hand signal if they wanted to 'give their jaw a rest'. Some even preferred to use their own music player and operated this for themselves during treatment.

The child for whom the treatment was aborted following cannulation had previously had treatment under GA but needed further root canal therapy and as such was referred for IV sedation to reduce the need for a further GA. However, although he was co-operative for cannulation he soon became physically aggressive, and had been known to behave in this way before. We use no restraint and feel that a patient, however anxious must be at least willing to try to co-operate, therefore treatment was abandoned both in the interest of staff safety and avoidance of over sedation and further excitation.

The majority of these children had failed to accept treatment previously by other means. Therefore, in this study the acceptance of dental treatment, especially during their first experience with propofol infusion, was used as the means of determining a successful outcome rather than by utilizing anxiety questionnaires. Moreover, the pathway of care was being developed during this same time-period and so the children in this sample were still being referred, from various sources within the department, directly onto this service making the uniform use of anxiety questionnaires difficult. This has since been rectified. The dental treatment that was conducted was predominately conservation of permanent teeth using amalgam or adhesive restorations but also included primary and permanent tooth extraction(s), fissure sealants or root canal therapy in addition in some cases. The relatively lower number of treatment units compared to that reported by Sapsford *et al*. might be related to the fact that this was each child's first IV visit and so the 'easiest' quadrant or item of treatment was selected [37]. Indeed, in a few cases the child urged us to 'do more' or 'go on' as they found the treatment so easy.

Other researchers have reported pain at the infusion site [44,46] and an itchy nose [44]. The increase in libido has not been commonly reported in relation to dental sedation but operators should ensure that they are appropriately chaperoned at all times. It has been suggested by some authors that practitioners could be accused of sexual impropriety by patients experiencing amorous, disinhibited behaviour or sexually orientated hallucinations during propofol sedation and opinion varies as to whether the patient should be informed that this may occur [47–49].

Whilst there are concerns about the prolonged use of propofol in children in intensive care units, there have been no reports relating to its use as a conscious sedative agent for short treatment periods. Nevertheless there are still relatively few studies in children and, most importantly, none where the operating dentist has been without the support of an anaesthetist acting as the sedationist [37,38]. Moreover, the therapeutic margin between sedation and general anaesthesia is small. Therefore, we recommended that the use of propofol in adolescents under the age of 16 years should be confined to hospital facilities, with the assistance of an anaesthetist, until further research evidence emerges.

Future study should include the effect of propofol on memory and cognitive ability, its efficacy as part of a pathway of care to reduce dental anxiety, especially in terms of the long-term acceptance of dental care. In addition, the merit of patient-controlled sedation in children is still to be clarified.

Conclusion

Sub-anaesthetic doses of propofol used as an IV conscious sedative agent facilitated the acceptance of dental treatment in 32 anxious children referred to a specialist hospital-based paediatric dentistry service without any adverse effect.

Résumé. *Objectifs*. Faire le point sur l'usage et le dosage du propofol en tant que nouvel agent sédatif conscient intra-veineux (IV) chez les enfants anxieux adressés à un service spécialisé de dentisterie pédiatrique.
Mise en place. Unité de Dentisterie Pédiatrique, Glasgow Dental Hospital and School.
Echantillon. Trente-quatre enfants, 25 filles et 9 garçons, âge moyen 12 ans 10 mois, avec un poids moyen de 54,6 kg [30 à 110 kg].
Méthodes. Rapport issu de 34 patients recevant une sédation intra-veineuse pour la première fois, en tenant compte de la dose poids et de la quantité de traitement effectuée.
Résultats. Trente-deux enfants ont accepté les soins dentaires lors de la première visite. Ils ont reçu une dose totale moyenne de 146,25 mg de propofol

[10 mg à 356 mg]; en relation avec le poids de corps, la moyenne était de 2,5 mg/kg [0.2 à 5.4 mg/kg]. Le traitement a consisté en scellements de sillons, amalgame et restaurations adhésives, endodontie et extractions multiples ou unitaires. La sédation et la récupération ont été sans histoire.
Conclusions. Les doses sous-anesthésiques de propofol utilisées pour sédation consciente IV ont facilité les traitements dentaires chez les enfants anxieux.

Zusammenfassung. *Ziele*. Bericht über Anwendung und Dosierung von Propofol, einem neuen intravenösen Medikament zur Analgosedierung von ängstlichen Kindern, welche in eine spezialisierte Einrichtung für Kinderzahnheilkunde über wiesen wurden.
Untersuchungsumgebung. Bereich Kinderzahnheilkunde, Universitäts-Zahnklinik Glasgow.
Stichprobe. 34 Kinder, 25 Mädchen und 9 Jungen, mittleres Alter 12 Jahre und 10 Monate, durchschnittliches Körpergewicht 54.6 kg (Spannweiter 30–110 Kg).
Methoden. Bericht von 34 Patienten, welche erstmals eine intravenöse Analgosedierung erhielten, unter Berücksichtigung der gewichtsbezogenen Dosierung und dem umfang der durchgeführten Behandlung.
Ergebnisse. 32 Kinder akzeptierten erfolgreich eine restaurative Zahnbehandlung bei der ersten Sitzung, sie erhielten im Mittel eine Dosis von 146.25 mg Propofol (10 mg bis 356 mg). Bezogen auf das Körpergewicht lag der Mittelwert bei 2.5 mg/kg (0.2 bis 5.4 mg/kg). Die Behandlungsmaßnahmen umfassten Fissurenversiegelungen, Amalgamfüllungen und Adhäsivfüllungen, Wurzelkanalbehandlung sowie einzelne oder multiple Extraktionen. Sedierung und Aufwachphase waren ohne besondere Vorkommnisse.
Schlussfolgerungen. Subnakotische Dosierungen von Propofol zur intravenösen Analgosedierung ermöglichten die zahnärztliche Behandlung bei unkooperativen Kindern.

Resumen. *Objetivos*. Informar del uso y la dosis de profolol como nuevo agente endovenoso (EV) de sedación consciente, para niños ansiosos referidos a un servicio especilizado de odontopediatría.
Ubicación. Unidad de Odontopediatría, Hospital y Escuela Dental de Glasgow.
Muestra. Treinta y cuatro niños, 25 mujeres y 9 hombres, con un promedio de edad de 12 años y 10 meses, con un peso promedio de 54.6 kg [rango de 30–110 kg].
Métodos. Informe de 34 pacientes que recibieron sedación consciente intravenosa por primera vez con respecto a la dosis por peso y la cantidad de tratamiento completado.
Resultados. Treinta y dos niños aceptaron con éxito el tratamiento dental operatorio en su primera visita. Recibieron un promedio de dosis total de 146.25 mg de propofol [rango de 10 mg–356 mg] y en relación al peso corporal, el promedio fue de 2.5 mg/kg [rango de 0.2–5.4 mg/kg].
El tratamiento recibido incluyó sellado de fisuras, amalgamas y restauraciones adhesivas, tratamiento de conductos y extracciones simples o múltiples. La sedación y la recuperación no presentaron problemas.
Conclusiones. Las dosis sub-anestésicas de Propofol utilizada para sedación cosnciente EV, facilitó el tratamiento dental en niños ansiosos.

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