American Journal of Emergency Medicine 35 (2017) 710–715

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Intranasal fentanyl and inhaled nitrous oxide for fracture reduction: The FAN observational study

J. Hoeffe [a,*,1], E. Doyon Trottier [a], B. Bailey [a], D. Shellshear [c], M. Lagacé [a], C. Sutter [c], G. Grimard [b], R. Cook [a], F.E. Babl [c,d,e]

[a] Division of Emergency Medicine, Department of Pediatrics, CHU Sainte-Justine, Université de Montréal, Montréal, Canada
[b] Division of Orthopedics, Department of Surgery, CHU Sainte-Justine, Université de Montréal, Montréal, Canada
[c] Emergency Department, Royal Children's Hospital, University of Melbourne, Australia
[d] Murdoch Children's Research Institute, Australia
[e] University of Melbourne, Australia

ARTICLE INFO

Article history:
Received 23 September 2016
Received in revised form 3 January 2017
Accepted 3 January 2017

ABSTRACT

Introduction: Procedural sedation and analgesia (PSA) are frequently used for fracture reduction in pediatric emergency departments (ED). Combining intranasal (IN) fentanyl with inhalation of nitrous oxide (N_2O) allow for short recovery time and obviates painful and time-consuming IV access insertions.
Methods: We performed a bicentric, prospective, observational cohort study. Patients aged 4–18 years were included if they received combined PSA with IN fentanyl and N_2O for the reduction of mildly/moderately displaced fracture or of dislocation. Facial Pain Scale Revised (FPS-R) and Face, Leg, Activity, Cry, Consolability (FLACC) scores were used to evaluate pain and anxiety before, during and after procedure. University of Michigan Sedation Score (UMSS), adverse events, detailed side effects and satisfaction of patients, parents and medical staff were recorded at discharge. A follow up telephone call was made after 24–72 h.
Results: 90 patients were included. There was no difference in FPS-R during the procedure (median score 2 versus 2), but the FLACC score was significantly higher as compared to before (median score 4 versus 0, Δ 2, 95% CI 0, 2). Median UMSS was 1 (95% CI 1, 2). We recorded no serious adverse events. Rate of vomiting was 12% (11/84). Satisfaction was high among participants responding to this question 85/88 (97%) of parents, 74/83 (89%) of patients and 82/85 (96%) of physicians would want the same sedation again.
Conclusion: PSA with IN fentanyl and N_2O is effective and safe for the reduction of mildly/moderately displaced fracture or dislocation, and has a high satisfaction rate.

1. Introduction

Fractures are common injuries in children [1-3]. Closed reduction of fractures is often a painful procedure associated with a degree of physical force, and is one of the main indications for procedural sedation and analgesia (PSA) in a pediatric emergency department (ED) [4-7].

The use of intranasal (IN) fentanyl to treat acute pain in children has been studied in different settings, showing comparable analgesic effects to intravenous (IV) morphine [8-10]. Obtaining IV line insertion in children requires special skills and is often a painful and time consuming process. Providing analgesia with IN fentanyl allows for analgesia without the tedious process of obtaining IV access.

Nitrous oxide (N_2O)-oxygen mixtures have been used for PSA in the ED for many years [11]. It has few side effects, and its use in the pediatric emergency setting is well established for mildly painful and/or distressing procedures [12,13]. Although the exact mechanism of action is unknown, sedation is usually explained due to a noncompetitive inhibition of the NMDA-receptor, and analgesia via central opioid- as well as opioid-like-receptors [12]. Usually, concentrations between 50 and 70% are used [11]. Best results as far as effect/side effect ratio are for inhalation time of <15 min [14]. However, its analgesic effect for painful procedures remains limited [15,16].

Theoretically, the combination of inhaled N_2O and the IN administration of fentanyl is attractive as it would support the use of N_2O in more painful procedures, such as fracture reduction, and maintain the advantages of a short recovery time without IV access. This would be especially valuable in the setting of mildly to moderately displaced forearm fractures or dislocation, where manipulation time is known to be short. Additionally, using a narcotic with N_2O enhances sedative and anxiolytic effects while allowing the patient to talk and follow commands [17].

* Corresponding author.
E-mail address: julia.hoeffe@insel.ch (J. Hoeffe).
[1] Permanent address: Division of Pediatric Emergency Medicine, Department of Women, Children and Endocrinology, Inselspital Bern, Switzerland.

http://dx.doi.org/10.1016/j.ajem.2017.01.004
0735-6757/

So far, the reported use on this combination is sparse. To date, only one observational study has been published evaluating IN fentanyl and N_2O as PSA: Seith et al. [18] prospectively studied sedation depth and adverse events in 41 patients undergoing PSA for painful procedures. This study did not assess the analgesic efficacy of the combined agents.

Thus, we aimed to evaluate the analgesic efficacy and the safety of combined IN fentanyl and N_2O as PSA for reduction of mildly to moderately displaced fractures and dislocation in children seen in pediatric ED.

2. Methods

We performed a prospective, observational study at two tertiary pediatric children's hospitals in Canada and Australia. In center 1, patients were recruited in the pediatric ED as well as in the orthopedics' clinic from September 2014 to October 2015. In center 2, ED patients were recruited from April 2015 to October 2015. Patients between the age of 4 and 18 years were eligible if PSA consisted of a combination of IN fentanyl and N_2O for reduction of the following: mildly or moderately displaced fractures of the forearm, fractures of the wrist or the hand, dislocation of a finger or of the patella, or application of traction on displaced femur fractures.

Patients received IN fentanyl 1.5 mcg/kg (100 mcg max) via atomizer using the 50 mcg/ml concentration. Additional doses of 0.5 mcg/kg were administered for pain control up to a total of 2 mcg/kg (100 mcg max total) at the discretion of the physicians performing the PSA. N_2O was delivered as fixed 50/50% nitrous oxide/oxygen mixture via the Nitronox™ system (Porter Instruments) at center 1 and as a variable mixture with N_2O at 0%–70%/oxygen mixture via the Entonox™ system (BOC Health Care UK) at center 2 (but always using a 70%/30% mixture). Both are on-demand flow systems: patients self-administer the gas by inhaling through the mask. Manipulation was started after 3 min of N_2O administration. During the procedure, patients were monitored continuously by pulse oximetry and heart rate in both centers, and by capnography in center 1. Monitoring ended after an oxygen wash out period of 2–5 min following the use of N_2O administration when the patient had returned to his or her pre-procedural state. 100% oxygen was delivered via nasal flow until patient was able to sit up by him- or herself. Discharge was based on local guidelines.

2.1. Measures

For patient assigned pain scores, the Facial Pain Scale Revised (FPS-R) was used to evaluate the efficacy of the procedural sedation. The FPS-R scale consists of 6 faces, each representing a degree of pain, and corresponding numbers 0–2–4–6–8–10 (0 being “no pain”, 10 being “very much pain”) (Fig. 1). It has been validated to quantify pain and pain relief following analgesia in children as young as 4 years in different settings including the pediatric ED [19-21]. Its French translation to evaluate acute pain evaluation is supported by the French Haute Autorité de Santé [22], and this acceptance allows its use in a center with mostly French speaking patients (center 1). Data were collected immediately before and 10 min after the end of the sedation - when patients were asked about pain scores during the procedure and about pain score at that moment. Patients were also asked about recall of the procedure, and were given the option to state ‘no recall’.

We also used the Face, Leg, Activity, Cry, Consolability Pain and Anxiety (FLACC) score to evaluate the observer based efficacy of PSA (Fig. 2) [23]. While it has limitations in procedural use it is a widely accepted observational score for postoperative pain and for acute procedures in children [20,21,23-25]. The scale was applied by a researcher or a trained researcher assistant before, during and 10 min after procedural sedation. Furthermore, sedation depth was recorded using the University of Michigan Sedation Scale (UMSS) during the sedation and 10 min after the end of sedation (Fig. 3) [26].

Side effects were recorded through a questionnaire to patients and parents after the procedure. Adverse events were recorded and categorized as suggested by the Consensus Panel on Sedation of the Research of Pediatric Emergency Care (PERC) and the Pediatric Emergency Care Applied Research Network (PECARN) [27]. Additionally, all other side effects were recorded, and a follow-up telephone call was made 24–72 h later to evaluate late side effects and adverse events.

Using surveys, general satisfaction of patients, parents and health care providers were collected separately. For the different surveys, different scales were used: Patients were asked on a scale of 0–10 with corresponding faces (0 = no satisfaction at all, 10 = very satisfied) how satisfied they were with the PSA. Parents were asked to determine their satisfaction on a scale from 0 to 5 (0 = very satisfied, 5 = not satisfied at all). Both parties also were asked if they would want the same sedation in the future for a similar procedure (yes or no). The surveys also included questions on sedations in the past as well as side effects. Health care provider questions included details on the fracture/dislocation type, overall satisfaction on a scale from 1 (not satisfied at all) to 5 (very satisfied), comparison with other PSA, and interest in future PSA with this drug combination for similar procedures (yes or no) as well as free text for additional comments.

2.2. Data collection and statistical analysis

For the purpose of data analysis, all data were entered in an Excel database (Microsoft Inc., Richmond, WA) and analyzed with SPSS v20 software (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Median differences of FPS-R and FLACC before, during, and after procedure were analyzed. Median depth of sedation and mean or median results for each question of the surveys were calculated. Responded questions were used to define denominator or n, respectively. Percentages were calculated using these numbers. Key categorical data are presented with 95% confidence intervals.

The primary outcome was the difference between the FPS-R score prior to and during the procedure. We also compared the FLACC score prior to and during the procedure. For FLACC score of >6, we compared time interval between fentanyl and N_2O administration. For the main side effect (vomiting), we compared duration of N_2O, time interval

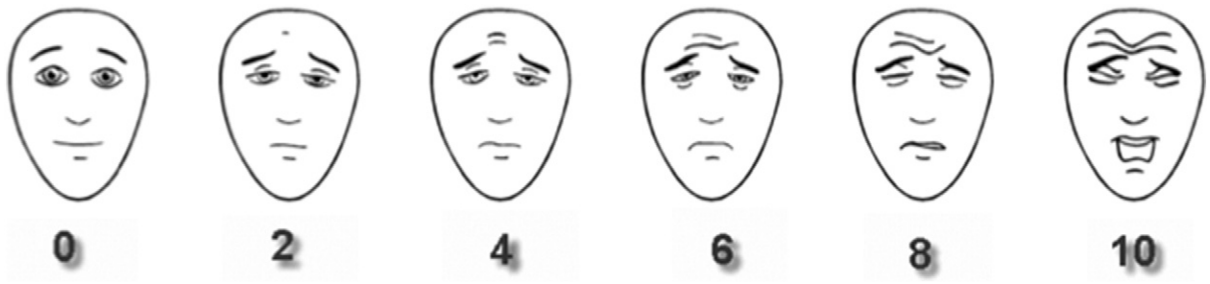

Fig. 1. Faces Pain Scale-Revised (FPS-R). www.iasp-pain.org/fpsr. Copyright ©2001, International Association for the Study of Pain®. Reproduced with permission. [19].