SOHAG MEDICAL JOURNAL
Vol. 22 No. 2 July 2018

Comparative Study Between Dexmedetomidine and Fentanyl For Analgesia and Prevention of Emergence Agitation in Children Undergoing Cochlear Implantation

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Abstract

Objective: This investigation aims to compare fentanyl with Dexmedetomidine as regards:
1. Their efficacy 2. Provide better quality of surgical field during cochlear implantation, including deliberate hypotension.
3. The effect of both medications on postoperative pain.
4. Recovery time.
5. Emergence agitation**. Patients and Methods:**
The study was undertaken following the agreement of the Ethical Committee of Sohag University Hospital and the acquisition of informed consent from the patient's parents.
Fifty juvenile patients (ASA I or II) scheduled for cochlear implantation were classified randomly into the dexmedetomidine (D) and the fentanyl (F) groups. Anesthesia was initiated in group (D) with an intravenous bolus of dexmedetomidine at a dosage of 2 µg/kg, administered slowly over 10 min, then a continuous infusion at a rate of 0.7 µg/kg/h was conducted until the conclusion of the procedure. In the (F) group, anesthesia was initiated by an intravenous administration of fentanyl at a dosage of 1 µg/kg over 10 minutes, then a continuous infusion was conducted at a rate of 0.1 mg/kg/h. Subsequently, I.V. propofol and atracurium are administered to both groups. We compared the two groups on a number of metrics, including surgical field quality, intraoperative hemodynamics, recovery and discharge timelines, objective pain levels after surgery, and the need for rescue analgesics and anti-emetics in the post-anesthesia care unit (PACU).
Results: The D group had a marginal reduction in heart rate (HR) compared to the fentanyl group. These parameters were significantly reduced in the D group relative to the baseline throughout the operation. The Modified Aldrete Score is superior in the D group compared to the F group.
A significant variation existed between both groups concerning the objective pain score. A significant disparity existed between the two groups, with Group D exhibiting a more expedited recovery period compared to Group F, rendering the data meaningful.
Conclusion: The infusion of dexmedetomidine during cochlear implantation in young individuals was more effective in causing controlled hypotension. It facilitated swift recovery from anesthesia and diminished the use of analgesics in the PACU.

Introduction

Surgery of cochlear implantation is a great advance in otology for patients with deaf mutism but it carries a great challenge to the anesthesiologist (15).
Anesthetic management includes bloodless surgical field to facilitate microsurgery, efficient airway management, careful head positioning to avoid venous obstruction, and congestion, restricted usage of muscle relaxants to induce controlling the facial nerve by peripheral nerve activator, smooth recovery, and adequate postoperative care without nausea and vomiting (13).

Controlled hypotension can be attained with a mix of pharmacological medications, including inhalational anesthetics, opioids, vasodilators, beta-blockers, magnesium sulfate, and alpha-2 adrenergic agonists. Physical treatments, by elevating the operated area above the heart, have diminished blood pressure in that region and lowered venous pressure through postural maneuvers (4, 16). Dexmedetomidine is an alpha-2 adrenergic agonist that exhibits sedative and analgesic properties. Even at supramaximal plasma concentrations, it does not cause respiratory failure (8). During intubation and extubation, it suppresses sympathetic activity and the responses of the airway and circulatory system. (5).
Fentanyl is a powerful synthetic opioid analgesic characterized by its quick onset and brief duration of action. It is a potent agonist at the mu-opioid receptor.

Analgesia and emerging agitation: recovery from anesthesia frequently leads to pain, increasing catecholamine levels. Anesthesia residuals simultaneously impair respiration. Consequently, α2-adrenoceptor agonists may be advantageous in the postoperative phase due to their sympatholytic and analgesic properties without inducing respiratory failure.

Objective

This investigation aims to compare fentanyl with dexmedetomidine in terms of:

1. Their effectiveness in including deliberate hypotension.
2. Provide a better surgical field quality during cochlear implantation.
3. The effect of both medications on postoperative pain.
4. Recovery time.
5. Emergence agitation.

Patient and methods

The investigation was performed under the agreement of the Ethical Committee of Sohag University Hospital and the acquisition of informed consent from the patient's parents.

Inclusion criteria

Fifty individuals categorized as ASA physical status I or II, aged between 6 months and 8 years, and slated for elective cochlear implantation, were involved in this investigation.

Exclusion criteria

Patients that were excluded from the study included children with:
Individuals with known allergy to fentanyl or dexmedetomidine.
Individuals with fever. Coagulopathy.
Extended QT interval with ventricular arrhythmia. Individuals with congenital heart diseases. Randomization was achieved by the utilization of automated randomization tables.
All of the participants had a preoperative assessment comprising medical history, physical investigation, as well as standard laboratory tests (CBC, PT, PTT, INR, urea, creatinine, SGPT, SGOT, albumin, bilirubin, and serum electrolytes). A cardiology consultation and pre-operative electrocardiogram will be performed. A thorough assessment of the airway will be performed.
Solid meals were not permitted six hours prior to surgery; however, clear fluids were allowed until two hours before the procedure. Children were randomly assigned to the dexmedetomidine (D) group and the fentanyl (F) group, with 26 participants in each group. Preparation of dexmedetomidine (vial = 2 mL) 100 µg/mL and fentanyl ampoule 100 µg/2 mL was done.

If the HR dropped 20% below the baseline value, 0.02 mg/kg of I.V. atropine was administered to treat bradycardia. The dosage of fluids will be 10 mL/kg/h and will consist of a 1:1 ratio of normal saline to 5% dextrose.

To ensure the patient does not cough and dislodge the implant's electrode array, the patient will be extubated under deep anesthetic before being brought to the recovery room at the end of the procedure.

Data collection

Heart rate (HR) and MAP. Data were collected at baseline, 1-minute post-induction, 1-minute post-intubation, and subsequently every 15 min until the conclusion of the procedure.
Total dosage of dexmedetomidine and fentanyl.

Objective Pain Scale (OPS) Requirement for increased analgesia.

Diclofenac suppository (12.5 or 25 mg) was administered if OPS were classified as P4. The dosage was administered based on body weight, namely 2 mg/kg.
Quality assessment: the surgeon, who was unaware of the chosen hypotensive agent, was requested to evaluate the operative field quality.
All patients' recovery and discharge times were recorded.
The timeframe from when sevoflurane was stopped until a modified Aldrete recovery score of 9 or higher was considered recovery time. The duration until the child fulfilled the Post-Anesthesia Care Unit (PACU) discharge criteria was deemed the discharge time. This period began when the procedure was finished and ended when the child was ready to go home.
Nausea and vomiting lasted for 24 hours after surgery. To alleviate nausea and vomiting, ondansetron was administered intravenously at a dosage of 0.1 mg/kg. It was noted how many patients experienced apnea. No one from the anesthesiology team was involved in either the agent's preparation or administration; their sole responsibility was to record data during and after the procedure.

Statistical Analysis

All the parameters were recorded, tabulated, and analyzed statistically compared between the two groups to identify any significant differences.Stata Intercooled version 9.2 was utilized for data analysis. A student t-test was used to compare the means of two groups in the quantitative data analysis. The data that did not follow a normal distribution were compared using the Mann-Whitney test.

Results:

The chi-square test and the Fisher exact test were utilized to compare the qualitative data. The data was compiled using an Excel spreadsheet. A p-value <0.05 was considered significant.

The use of dexmedetomidine during cochlear implantation in pediatric individuals was more efficacious in achieving intentional hypotension and enhancing the surgical field quality compared to fentanyl administration. It accelerated recovery from anesthesia and diminished the requirement for analgesics in the PACU. Dexmedetomidine had enhanced analgesic properties, reducing the occurrence of postoperative agitation and alleviating nausea and vomiting. The study comprised 50 patients who had anesthesia for cochlear implantation surgery, categorized into two groups: Group D provided Dexmedetomidine to twenty-five individuals. Group F comprised 25 patients who were administered Fentanyl.

The two groups did not significantly differ in MAS. A notable disparity existed between the two groups, with group D exhibiting a more expedited recovery period compared to group F; the result is statistically significant. Table 1
Concerning OPS: a study of groups in which patients came without pain revealed that A statistically significant variation existed between the two groups in the number of patients presenting without discomfort at the time intervals of 1/2, 1, and 2 h. No statistically insignificant variations were shown between the two groups for patients presenting without pain at the time intervals of 4 to 24 h.

The patient exhibited modest discomfort: There was a statistically significant difference between the two groups experiencing mild pain at the time intervals of 1/2 and 1 h. There were no statistically significant differences between the two groups for patients with minor discomfort at the time span of 2 to 24 h.

The patient exhibited moderate pain: A statistically significant variation was seen between both groups at 1/2 and 1 h in patients experiencing moderate pain.

The patient exhibited extreme pain: There are no statistically significant variations between the two groups for patients experiencing severe pain at the time intervals of 1/2 to 24 h.
Regarding the increased use of the tested medicine, there was no significant difference.
A statistically significant difference existed between the two groups about the necessity for additional analgesics.

There was a statistically negligible difference between the two groups about the quality of the surgical field.

The disparity in operational length between the two groups was statistically insignificant. In the D group, the duration was 155.24 ± 28.79 min, but in the F group, it was 162.2 ± 31.16 min. A notable difference (p-value < 0.001) in recovery time was seen, with the D group demonstrating a reduction of 11.24 min compared to the F group, which had a recovery time of 13.92 min. A statistically significant difference (p-value < 0.05) was noted in discharge times, with the D group averaging 24.4 min, whereas the F group

averaged 41.6 min. A statistically significant difference was seen between the two groups for postoperative agitation and vomiting.

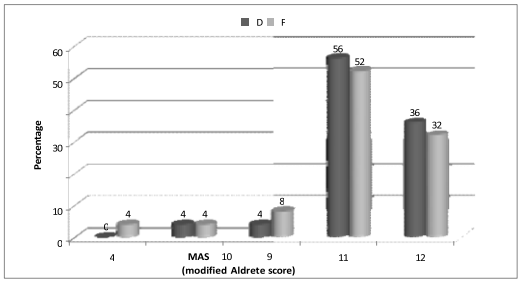
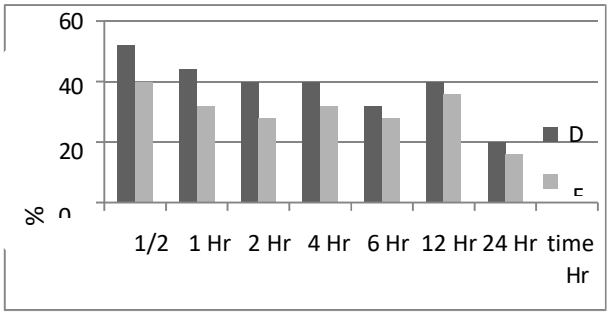
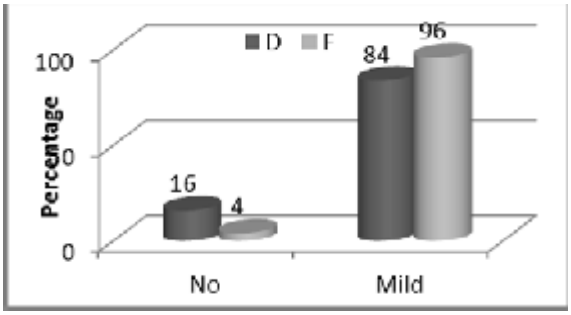


Figure (1) MAS between both groups



(2) Comparison between D group and F group as regard objective pain score



Figure(3)Quality *of* surgical field

Discussion:

Significant progress in otology for individuals with deaf mutism presents considerable challenges for the anesthesiologist (Pedersen et al. 2000). Anesthetic management encompasses a bloodless surgical field to enhance microsurgery, effective airway management, meticulous head positioning to prevent venous obstruction and congestion, restricted use of muscle relaxants to enable monitoring of the facial nerve via a peripheral nerve stimulator, seamless recovery, and sufficient postoperative care devoid of nausea and vomiting (Morgan et al. 2006). (Morgan et al. 2006).

Fentanyl is a powerful synthetic opioid analgesic characterized by a quick onset and brief period of action. It is a potent agonist at the mu-opioid receptor. Analgesia and emerging agitation: recovery from anesthesia frequently leads to pain, increasing catecholamine levels. At the same time, anesthesia residualscompromise breathing. Therefore, α2-adrenoceptor agonists may be beneficial in the postoperative period owing to their sympatholytic and analgesic effects, without causing respiratory depression (Guler et al. 2005). The major objective was to assess the

effectiveness of fentanyl compared to dexmedetomidine in inducing intentional hypotension and improving the surgical field quality during cochlear implantation. The effects of both drugs on postoperative pain and recovery time were assessed. The average age of our study group was

4.81±2.25 years in the Dexmedetomidine group and 3.88±0.86 years in the Fentanyl group. The Dexmedetomidine group comprised 52.3% females and 47.6% males, whereas the Fentanyl group consisted of 48% females and 52% males. The mean body weight was 17.57±4.92 in group D and 15.76±2.18 in group F. The average duration of operation was 155.24±28.79 min in the Dexmedetomidine group and 162.2±31.16 min in the Fentanyl group. In the investigation by El Saied et al. (2016), the mean age of the D group was 5.91 ± 1.62 years, while the F group had an average age of 6.17 ± 1.67 years. The D group comprised 38.5% men and 61.5% females, whereas the F group consisted of 42.3% males and 57.7% females. The average time of operation was 121.53±25.6 min in the D group and 117.88±26.4 min in the F group (El Saied et al. 2016).

Dexmedetomidine is a powerful α2 adrenergic agonist, exhibiting a distribution half-life of 8 minutes and a terminal half-life of 3.5 h. Its brief half-life facilitates straightforward titration, rapid recovery, and a reduction in side effects associated with extended sedation. It offers sufficient sedation while maintaining robust circulatory and respiratory stability (Nelson et al. 2003).

a2-adrenoceptors exist on the dorsal horn neurons of the spinal cord and can release endogenous opiate compounds.

Consequently, a2-adrenoceptor agonists may be utilized in pain management as well as may reduce intra-operative opioid doses, akin to clonidine (Xu et al. 2000).

The dosing protocol of the evaluated medication is contentious.

At numerous trials, dexmedetomidine is administered for its sedative, amnestic, and analgesic effects at a bolus dose of <0.5 μg/kg in pediatric patients to prevent bradycardia, followed by a titrated infusion with a maximum dose of 2 μg/kg/h. At these dosages in pediatric patients, Dexmedetomidine functions as an efficacious sedative and analgesic without notable hemodynamic repercussions (Hall et al. 2000, Schnabel et al. 2013).

Concerning hemodynamics in our study, we observed that mean HR and MAP progressively declined after induction for up to 180 min, without significant differences between both groups, resulting in enhanced surgical field quality. This aligns with the findings of El Saied et al. (2016), who reported that dexmedetomidine produced a more substantial reduction in intra-operative HR and MAP compared to fentanyl.

Kim et al., 2015 Concurred with our study. Mason et al. (2006) were the pioneers in investigating the sedative effects of dexmedetomidine on juvenile patients undergoing radiological imaging investigations. It was observed that dexmedetomidine resulted in a decrease in HR and MAP, which was clinically acceptable for the pediatric population. These findings align with the outcomes of the current investigation. Koroglu et al. (2005) observed that dexmedetomidine resulted in a decrease in HR only when compared to propofol in pediatric patients undergoing MRI studies. Tanskanen et al. (2006) reported that dexmedetomidine was an excellent

anesthetic adjuvant because of the perioperative hemodynamic stability and the faster tracheal intubation that was obtained in comparison with fentanyl in patients undergoing brain surgery.

Feld et al. (2006) performed a comparative analysis of dexmedetomidine and fentanyl in relation to bariatric surgery. Dexmedetomidine was reported to diminish sympathovagal balance and HR during the surgery more markedly than fentanyl. Ali and El Ghoneimy (2010) conducted a comparison of dexmedetomidine and fentanyl in pediatric patients undergoing extracorporeal shock wave lithotripsy, noting a significant reduction in MAP and HR from baseline during the procedure in both cohorts; these results are consistent with this investigation. Turgut et al. (2008) reported that MAP values were

significantly higher in the D group compared to the F group only after intubation, but were significantly decreased in the D group relative to the F group both before and after extubation during lumbar laminectomy surgery. The research conducted by Turgut et al. (2008) demonstrated no statistically significant variation in HR among the groups. Dikmen et al. (2010) illustrated that dexmedetomidine infusion reliably produced sustained, controlled hypotension, enhancing visibility during middle ear surgery without requiring a supplementary powerful hypotensive agent in low-flow anesthesia. Dexmedetomidine reduced the need for isoflurane and fentanyl during deliberate hypotension and alleviated cardiovascular responses perioperatively (Dikmen et al. 2010).

As regards modified aldrate score (MAS), we found that it was high at 11 in 56% of the Dexmedetomidine group and52% of the Fentanyl group without significant differences. The MAS was 12 in 36% in the Dexmedetomidine group and 32% in the Fentanyl group, with no significant difference seen. Consistent with our findings, El Saied et al. (2016) reported no statistically significant difference between the two groups concerning the modified Aldrete score. Postoperative OPS was considerably lower in the D group compared to the F group at all time points up to 24 hours post-surgery. Only 12 patients in the D group required postoperative analgesia, whereas 20 patients in the F group did, with a significant P value (<0.001).

The mean recovery time was much shorter in the D group, averaging 11.240 ± 0.5228 min, compared to 13.920 ± 3.3407 min in the F group.

The discharge time exhibited a substantial difference between the dexmedetomidine group and the F group, with the D group averaging 24.4 ± 12.47 min and the fentanyl group averaging 41.6 ± 19.31 min.

In our study, the incidence of agitation with fentanyl was mild in 48% of patients, whereas 32% exhibited moderate agitation.

Our study indicates that intraoperative continuous dexmedetomidine infusion (0.7 mg/kg/h) till extubation effectively reduces the incidence of emerging agitation following cochlear implant surgery without delaying extubation or increasing the occurrence of additional problems. Moreover, the intraoperative administration of dexmedetomidine resulted in more stable hemodynamic alterations during extubation and improved patient-reported overall quality of recovery 24 h post-surgery.

Herein, the incidence of nausea and vomiting was significantly less in the dexmedetomidine group than fentanyl group as none of our patients in the dexmedetomidine suffered from nausea nor vomiting, while in the fentanyl group, 8 patients suffered from nausea, and 10 patients presented with vomiting.

Conclusion

The infusion of dexmedetomidine during cochlear implantation in pediatric individuals was superior in causing intentional hypotension and enhancing the surgical field quality compared to fentanyl infusion. It facilitated fast recovery from anesthesia and diminished the requirement for analgesics in the PACU. Dexmedetomidine was superior for analgesia, reducing the occurrence of emerging agitation and minimizing postoperative nausea and vomiting.

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