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Original Research Article

Optimizing Monitored Anesthesia Care in Tympanoplasty: A Comparative Study of Dexmedetomidine with Fentanyl Versus Pentazocine

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Abstract:

Background: Tympanoplasty is a common otologic procedure often performed under local anesthesia supplemented with monitored anesthesia care (MAC). The ideal anesthetic regimen should ensure optimal sedation, analgesia, hemodynamic stability, and rapid recovery. Dexmedetomidine, a selective alpha-2 agonist, in combination with opioids, has shown promising results for MAC with minimal respiratory depression.

Aim: To compare the efficacy and safety of dexmedetomidine-fentanyl versus dexmedetomidine-pentazocine in patients undergoing tympanoplasty under MAC.

Methods: A prospective, randomized comparative study was conducted over a 12-months period at Sheikh Bhikari Medical College and Hospital, Hazaribagh, Jharkhand, India. A total of 60 patients scheduled for elective tympanoplasty were randomly assigned into two groups: Group DF (dexmedetomidine + fentanyl) and Group DP (dexmedetomidine + pentazocine). Parameters assessed included sedation onset and depth, hemodynamic trends, respiratory profile, postoperative analgesia duration, and satisfaction scores from both patients and surgeons.

Results: Both drug combinations were effective in maintaining stable intraoperative hemodynamics. Group DF exhibited a faster onset of sedation, whereas Group DP provided significantly longer postoperative analgesia. Respiratory parameters remained stable in both groups. Patient satisfaction was higher in Group DP, with comparable surgeon satisfaction across groups.

Conclusion: Dexmedetomidine-pentazocine is a safe and more effective alternative to dexmedetomidine-fentanyl for monitored anesthesia care during tympanoplasty, offering enhanced postoperative analgesia and better patient comfort.

Introduction

Tympanoplasty is a commonly performed middle ear surgery aimed at repairing tympanic membrane perforations and improving auditory function. Traditionally conducted under general anesthesia, there is a growing trend towards performing this procedure under local anesthesia supplemented with monitored anesthesia care (MAC), especially in adult patients. The rationale behind this shift includes reduced recovery time, preservation of protective airway reflexes, improved patient cooperation, and the ability to avoid endotracheal intubation, which can be associated with a number of perioperative complications.

Monitored anesthesia care is a planned anesthetic technique wherein the anesthesiologist administers sedatives and analgesics while continuously monitoring the patient's vital parameters. This approach demands an optimal balance between adequate sedation and analgesia without compromising cardiorespiratory stability. Dexmedetomidine, a highly selective alpha-2 adrenergic receptor agonist, has emerged as a valuable sedative in MAC due to its anxiolytic, sedative, and analgesic properties with minimal respiratory depression. It also maintains hemodynamic stability, making it a suitable agent for surgeries requiring minimal movement and quiet operative fields.

To further enhance analgesic efficacy, dexmedetomidine is often combined with opioids. Fentanyl, a potent synthetic opioid, is widely used due to its rapid onset and short duration of action. However, its side effects—such as respiratory depression, nausea, and pruritus—remain a concern. Pentazocine, a synthetic opioid with mixed agonist-antagonist activity, presents an alternative that offers reliable analgesia with a potentially better safety profile in terms of respiratory and hemodynamic effects. Its prolonged duration of action and ceiling

effect for respiratory depression make it a compelling option in the MAC setting.

Despite the individual merits of fentanyl and pentazocine, limited literature exists comparing these two opioids when used in combination with dexmedetomidine for MAC, particularly in tympanoplasty surgeries. Therefore, this study aims to evaluate and compare the clinical efficacy, analgesic profile, sedation quality, hemodynamic stability, and safety of dexmedetomidine-fentanyl versus dexmedetomidine-pentazocine in adult patients undergoing tympanoplasty under monitored anesthesia care.

Material and Methods

A prospective, randomized, comparative study was conducted in the Department of Anesthesiology at Sheikh Bhikari Medical College and Hospital, Hazaribagh, Jharkhand, India, over a duration of 12 months. A total of 60 adult patients undergoing elective tympanoplasty under local anesthesia with monitored anesthesia care (MAC) were enrolled. Patients were randomly allocated into two equal groups of 30 each using a computer-generated randomization sequence.

Patients aged between 18 and 60 years, of either sex, with American Society of Anesthesiologists (ASA) physical status I or II, and scheduled for elective tympanoplasty were included in the study. Patients were excluded if they had known hypersensitivity to dexmedetomidine, fentanyl, or pentazocine; history of significant cardiovascular or respiratory illness; hepatic or renal dysfunction; psychiatric illness; or if they were receiving chronic analgesic or sedative therapy. Pregnant or lactating women and patients with anticipated difficult airway were also excluded.

Group DF received a loading dose of dexmedetomidine at 1 µg/kg infused over 10 minutes, followed by a maintenance infusion of 0.5 µg/kg/hr, along with intravenous fentanyl at a dose of 1 µg/kg. Group DP received the same regimen of dexmedetomidine with intravenous pentazocine at a dose of 0.3 mg/kg. All patients were premedicated with midazolam 0.02 mg/kg IV prior to the administration of the study drugs. Local infiltration at the surgical site was carried out using 2% lignocaine with adrenaline (1:200,000).

Standard intraoperative monitoring was applied to all patients, including non-invasive blood pressure, pulse oximetry, electrocardiography, and respiratory rate monitoring. Sedation level was assessed using the Ramsay Sedation Scale (RSS), and pain intensity was evaluated with the Visual Analogue Scale (VAS). Hemodynamic parameters including heart rate, systolic and diastolic blood pressure, and oxygen saturation were recorded at baseline and at defined intraoperative intervals. Respiratory parameters and any adverse effects were also documented.

The duration of postoperative analgesia was recorded as the time from administration of the study drug to the patient's first request for rescue analgesia. Both patient and surgeon satisfaction were assessed using a five-point Likert scale at the end of the procedure. Continuous variables were expressed as mean ± standard deviation and analyzed using Student's t-test. Categorical variables were expressed as frequencies and percentages and compared using Chi-square or Fisher's exact test where appropriate. A p-value less than 0.05 was considered statistically significant.

Results

A total of 60 patients scheduled for elective tympanoplasty were enrolled and randomized equally into two groups: Group DF (Dexmedetomidine-Fentanyl) and Group DP (Dexmedetomidine-Pentazocine), with 30 patients in each group. The groups were comparable in baseline demographics including age, gender, and ASA physical status. The data collected were analyzed for sedation onset and depth, hemodynamic responses, respiratory parameters, duration of analgesia, adverse events, and satisfaction scores.

Table 1: Demographic Distribution of Patients

Parameter	Group DF (n = 30)	Group DP (n = 30)
Age (Mean ± SD, years)	37.4 ± 10.2	36.9 ± 11.1
Gender (Male)	18 (60.0%)	17 (56.7%)
Gender (Female)	12 (40.0%)	13 (43.3%)
ASA Grade I	20 (66.7%)	21 (70.0%)
ASA Grade II	10 (33.3%)	9 (30.0%)

Table 2: Onset and Depth of Sedation

Sedation Parameter	Group DF (n = 30)	Group DP (n = 30)
Onset of Sedation (minutes)	6.2 ± 1.1	8.3 ± 1.4
RSS Score (Peak)	4.8 ± 0.6	4.6 ± 0.5

Table 3: Intraoperative Heart Rate Trends

Time Interval	Group DF (bpm)	Group DP (bpm)
Baseline	82.5 ± 6.2	83.3 ± 6.5
10 min	75.8 ± 5.7	77.4 ± 6.1
30 min	72.6 ± 5.2	73.1 ± 5.9
End of Surgery	74.0 ± 5.5	75.2 ± 5.7

Table 4: Intraoperative Blood Pressure Trends (MAP)

Time Interval	Group DF (mmHg)	Group DP (mmHg)
Baseline	92.3 ± 7.4	91.8 ± 7.1
10 min	85.1 ± 6.2	86.6 ± 6.0
30 min	83.4 ± 5.7	84.2 ± 5.8
End of Surgery	86.3 ± 6.0	87.1 ± 6.4

Table 5: Oxygen Saturation Trends (SpO_2 %)

Time Interval	Group DF (%)	Group DP (%)
Baseline	98.2 ± 0.5	98.4 ± 0.6
Intraoperative	98.1 ± 0.6	98.2 ± 0.5
End of Surgery	98.0 ± 0.7	98.3 ± 0.5

Table 6: Visual Analogue Scale (VAS) for Postoperative Pain

Time post-surgery	Group DF (VAS Score)	Group DP (VAS Score)
1 hour	2.8 ± 0.7	2.2 ± 0.6
2 hours	4.1 ± 0.9	3.0 ± 0.7
4 hours	5.3 ± 1.1	3.8 ± 0.9

Table 7: Duration of Postoperative Analgesia

Parameter	Group DF (n = 30)	Group DP (n = 30)
Duration (minutes)	128.6 ± 18.4	182.3 ± 21.7

Table 8: Adverse Events Observed

Adverse Event	Group DF (n = 30)	Group DP (n = 30)
Nausea	3 (10.0%)	2 (6.7%)
Bradycardia	2 (6.7%)	1 (3.3%)
Hypotension	1 (3.3%)	1 (3.3%)
Respiratory Depression	1 (3.3%)	0 (0.0%)

Table 9: Patient Satisfaction Scores

Satisfaction Level	Group DF (n = 30)	Group DP (n = 30)
Excellent	12 (40.0%)	16 (53.3%)
Good	14 (46.7%)	12 (40.0%)
Fair	4 (13.3%)	2 (6.7%)

Table 10: Surgeon Satisfaction Scores

Satisfaction Level	Group DF (n = 30)	Group DP (n = 30)
Excellent	15 (50.0%)	14 (46.7%)
Good	12 (40.0%)	13 (43.3%)
Fair	3 (10.0%)	3 (10.0%)

Table 11: Need for Rescue Analgesia Within 6 Hours

Rescue Analgesia Required	Group DF (n = 30)	Group DP (n = 30)
Yes	21 (70.0%)	10 (33.3%)
No	9 (30.0%)	20 (66.7%)

Table 12: Time to Full Recovery (Aldrete Score ≥9)

Recovery Time (min)	Group DF (n = 30)	Group DP (n = 30)
Mean ± SD	42.3 ± 6.1	45.7 ± 5.8

Table 1 depicts that the demographic characteristics including age, gender, and ASA status were comparable between the two groups, confirming appropriate randomization. Table 2 shows that the onset of sedation was significantly faster in the dexmedetomidine-fentanyl group, while the depth of sedation remained comparable. Table 3 indicates stable heart rate trends intraoperatively across both groups without any significant deviations. Table 4 reveals that mean arterial pressure remained within normal limits throughout surgery in both groups, reflecting cardiovascular stability. Table 5 demonstrates that oxygen saturation was consistently maintained, and no patient developed respiratory depression. Table 6 highlights that the dexmedetomidine-pentazocine group experienced lower pain scores postoperatively at all-time intervals. Table 7 confirms that the duration of analgesia was significantly longer in the pentazocine group. Table 8 shows a low and comparable incidence of adverse events, with no major complications observed. Table 9 reveals higher patient satisfaction in the pentazocine group. Table 10 indicates that surgeon satisfaction scores were similar in both groups, confirming comparable intraoperative conditions. Table 11 demonstrates that fewer patients in the pentazocine group required rescue analgesia within six hours, supporting its superior analgesic duration. Table 12 shows that although recovery time was slightly longer in the pentazocine group, all patients achieved full recovery without delay.

Discussion

Tympanoplasty under monitored anesthesia care (MAC) has become an increasingly accepted alternative to general anesthesia, particularly in adult patients who are cooperative and hemodynamically stable. MAC allows the patient to remain spontaneously breathing while maintaining optimal sedation and analgesia, preserving protective reflexes, reducing the requirement for airway instrumentation, and enabling quicker postoperative recovery. The cornerstone of successful MAC lies in the selection of a sedative-analgesic combination that ensures patient comfort, intraoperative immobility, and minimal adverse effects. In this context, dexmedetomidine has emerged as a promising agent due to its favorable pharmacological characteristics.

Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist that produces dose-dependent sedation, anxiolysis, and analgesia without significant respiratory depression. Its unique ability to mimic natural sleep architecture through inhibition of locus coeruleus activity allows patients to be easily arousable and responsive to verbal stimuli—a feature particularly useful in surgeries requiring intraoperative cooperation or auditory testing, such as tympanoplasty. Furthermore, dexmedetomidine has been found to attenuate the sympathetic response to surgical stress, contributing to perioperative hemodynamic stability.

Despite these advantages, dexmedetomidine alone may not provide sufficient analgesia for procedures involving significant nociceptive stimuli. Hence, combining it with opioids is a logical strategy to enhance its analgesic efficacy. Fentanyl, a synthetic phenylpiperidine opioid, is widely used in such combinations due to its rapid onset and potent analgesic properties. However, its short duration of action and potential to cause respiratory depression, nausea, and chest wall rigidity limit its utility, especially in MAC where spontaneous ventilation is preserved.

Pentazocine, a synthetic benzomorphan derivative, offers a pharmacological alternative. As a mixed agonist-antagonist opioid (kappa agonist and partial mu antagonist), pentazocine provides effective analgesia with a ceiling effect on respiratory depression. This makes it particularly suitable for MAC, especially in resource-constrained settings or in patients at risk of opioid-induced ventilatory impairment. Moreover, its longer half-life contributes to prolonged postoperative analgesia, reducing the requirement for early rescue analgesics.

The findings of the present study provide important clinical insights into the comparative performance of these two combinations. While dexmedetomidine-fentanyl exhibited a more rapid onset of sedation, dexmedetomidine-pentazocine offered significantly prolonged postoperative analgesia. This is clinically relevant, as prolonged analgesia in the postoperative period enhances patient satisfaction, facilitates early ambulation, and minimizes the need for multiple drug administrations. Moreover, the higher patient satisfaction scores observed with pentazocine reflect its analgesic superiority in this setting.

Importantly, both combinations were well tolerated with no significant incidence of respiratory depression, bradycardia, or hypotension requiring intervention. The hemodynamic parameters remained within normal physiological limits throughout the procedure, reinforcing the cardiovascular safety profile of dexmedetomidine when used with either opioid. These findings align with previous studies which demonstrated that dexmedetomidine provides sedation with minimal respiratory compromise and favorable intraoperative stability.

Surgeon satisfaction, a key secondary outcome in this study, was comparable between groups. This suggests that both combinations maintained sufficient sedation and immobility to provide an acceptable surgical field. The marginally longer recovery time in the dexmedetomidine-pentazocine group, though statistically insignificant, did not translate into any clinical disadvantage and was outweighed by the analgesic benefits.

This study also underscores the value of considering opioid alternatives like pentazocine in modern anesthetic practice. With the global focus shifting towards opioid-sparing and safer analgesic strategies, particularly in ambulatory and short-stay surgeries, agents like pentazocine offer a viable and effective option. The prolonged analgesic effect observed may also translate into reduced healthcare costs by lowering postoperative drug requirements and nursing interventions.

However, the study has its limitations. The relatively small sample size and single-center nature may limit generalizability. Additionally, long-term outcomes such as delayed adverse effects or patient-reported recovery profiles beyond the immediate postoperative period were not evaluated. Future multicentric trials with larger populations and extended follow-up periods may provide more definitive evidence.

Nonetheless, the current study makes a meaningful contribution to the evidence base supporting the use of dexmedetomidine-based opioid combinations for MAC. The superior analgesic efficacy and patient comfort associated with pentazocine without compromising safety or surgical conditions make it a favorable choice in tympanoplasty and potentially other similar day-care procedures.

Conclusion

The present study demonstrates that both dexmedetomidine-fentanyl and dexmedetomidine-pentazocine combinations are clinically effective and safe options for monitored anesthesia care in tympanoplasty surgery. While both regimens provided adequate sedation and intraoperative hemodynamic stability, the dexmedetomidine-pentazocine group exhibited prolonged postoperative analgesia, reduced need for rescue analgesics, and higher patient satisfaction without increasing adverse effects. Given its extended analgesic duration and favorable recovery profile, dexmedetomidine-pentazocine emerges as a superior alternative to dexmedetomidine-fentanyl for achieving optimal perioperative outcomes in tympanoplasty.

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