Original Article

To Compare the Analgesic Efficacy of Inferior Alveolar Nerve Block and Mandibular Nerve Block for Elective Unilateral Mandibular Fracture Surgery Under General Anaesthesia: A Randomised Comparative Study

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Abstract

Background: Mandibular fracture surgery is associated with significant perioperative nociceptive stimulation and opioid requirement even under general anaesthesia. Regional nerve block may improve analgesia and haemodynamic stability. **Material and Methods:** This randomized comparative study included 100 patients undergoing elective unilateral mandibular fracture surgery under general anaesthesia. Patients were divided into two groups of 50 each. Group A received inferior alveolar nerve block and Group M received mandibular nerve block using 0.5% bupivacaine. Baseline profile, intraoperative and postoperative haemodynamic variables, additional fentanyl requirement and adverse effects were compared. **Results:** Both groups were comparable for age, gender, BMI, ASA grade and duration of surgery. Intraoperative heart rate was significantly lower in Group M from incision time onwards. At 15 minutes, heart rate was 94.86 ± 12.18/min in Group A and 86.97 ± 9.36/min in Group M ($p = 0.0004$). MAP was also significantly lower in Group M at 30, 45 and 60 minutes. Postoperative heart rate and MAP were significantly lower in Group M at all recorded time points up to 6 hours. Additional intraoperative fentanyl requirement was significantly lower in Group M compared to Group A (50.20 ± 13.65 µg vs 75.80 ± 17.40 µg, $p < 0.0001$). Time to first additional fentanyl was longer in Group M (36.85 ± 8.40 min vs 23.10 ± 6.25 min, $p < 0.0001$). Adverse effects were comparable between both groups. **Conclusion:** Mandibular nerve block provided better intraoperative and early postoperative analgesic profile than inferior alveolar nerve block in unilateral mandibular fracture surgery under general anaesthesia.

Keywords: Mandibular fracture, inferior alveolar nerve block, mandibular nerve block, bupivacaine, postoperative analgesia, fentanyl.

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Introduction

Mandibular fracture is one of the common injuries managed by oral and maxillofacial surgeons. It is commonly seen after road traffic accidents, fall, assault and other facial trauma. The mandible has important role in mastication, speech and airway support. Surgical fixation of mandibular fracture is therefore done not only for bony union but also for restoration of occlusion and function. Although general anaesthesia provides adequate operating condition, pain control during and after surgery remains an important part of perioperative management.

Pain after mandibular fracture surgery may be due to surgical incision, periosteal handling, fracture manipulation, plate fixation and soft tissue trauma. Inadequate analgesia can lead to sympathetic stimulation, tachycardia, hypertension, delayed recovery and higher opioid requirement. In trauma patients this is more important because mouth opening may be restricted and airway management may already be difficult. Use of regional nerve block along with general anaesthesia can improve analgesia and reduce perioperative opioid requirement. This concept is now increasingly used as part of multimodal analgesia in maxillofacial surgery.

The inferior alveolar nerve is a major sensory branch of the mandibular division of trigeminal nerve. Inferior alveolar nerve block is a commonly used technique for anaesthesia of mandibular teeth and adjacent structures. It is routinely used in dentistry and maxillofacial procedures because it is simple and familiar to most clinicians. The local anaesthetic is deposited near the mandibular foramen before the nerve enters the mandibular canal. However its success depends on proper identification of landmarks such as coronoid notch, mandibular ramus and pterygomandibular raphe. Failure of block can occur due to anatomical variation, wrong needle placement and

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inadequate spread of local anaesthetic.[1]
Mandibular nerve block is a more proximal block of the mandibular division of trigeminal nerve. Gow-Gates and Vazirani-Akinosi techniques are commonly described techniques for mandibular nerve anaesthesia. As the block is given at a higher level it can cover a wider mandibular nerve distribution when compared with conventional inferior alveolar nerve block. This may be useful in mandibular fracture surgery where pain may arise from teeth, bone, periosteum and surrounding soft tissue. Previous studies comparing Halstead, Gow-Gates and Vazirani-Akinosi techniques have shown that mandibular block techniques can provide effective mandibular anaesthesia, although onset time and technical difficulty may vary between techniques.[2,3]
Long acting local anaesthetic agents have special role in perioperative analgesia. Bupivacaine is commonly used because of its prolonged sensory blockade and postoperative analgesic effect. In mandibular surgery, bupivacaine based nerve blocks have been shown to reduce postoperative pain and opioid requirement. Mesgarzadeh et al. studied bilateral mental nerve block with bupivacaine in mandibular parasymphysis fracture and observed significantly less opioid requirement in the block group.[4] Kim et al. also described the role of local anaesthesia techniques in mandibular third molar surgery and noted the usefulness of long acting local anaesthesia for postoperative pain control.[5]
Evidence specific to mandibular fracture surgery is still limited. Venkatraman et al. in a randomized observer blinded study reported that ultrasound guided mandibular nerve block was effective for postoperative analgesia in mandibular fracture surgery and pre-emptive block reduced intraoperative opioid consumption.[6] Oono et al. also reported that perioperative nerve blockade reduced acute postoperative pain after orthognathic surgery, supporting the role of regional nerve block in orofacial surgical pain.[7] These findings suggest that nerve blocks can be useful adjuncts to general anaesthesia in mandibular procedures.
However, direct comparison between inferior alveolar nerve block and mandibular nerve block in elective unilateral mandibular fracture surgery is less commonly reported. Both techniques are used in clinical practice but their relative effect on intraoperative haemodynamic response, opioid requirement, duration of analgesia and adverse effects needs more evaluation. Therefore the present randomized comparative study was planned to compare the analgesic efficacy of inferior alveolar nerve block and mandibular nerve block in patients undergoing elective unilateral mandibular fracture surgery under general anaesthesia.

Materials and Methods

This randomized comparative study was conducted in the Department of Anaesthesiology, M.G.M. Medical College and M.Y. Hospital, Indore after approval from Institutional Ethics Committee. The study was conducted over a period of 12 months. A total of 100 patients were included and divided into two equal groups of 50 patients each.
Patients aged 18–65 years, belonging to ASA physical status I and II and posted for elective unilateral mandibular fracture surgery under general anaesthesia were included. Patients not giving written informed consent, patients with allergy to study drug and patients with coagulopathy or bleeding disorder were excluded.
Patients were allocated into two groups by odd-even method according to sequential enrolment number. Group A received ipsilateral inferior alveolar nerve block. Group M received mandibular nerve block. All patients underwent standard pre-anaesthetic assessment including history, systemic examination, airway assessment and routine investigations.
General anaesthesia was standardized in both groups. Premedication was given with intravenous glycopyrrolate and midazolam. Induction was done with fentanyl, propofol and succinylcholine. Anaesthesia was maintained with oxygen, nitrous oxide, sevoflurane and atracurium. Standard monitoring included ECG, non-invasive blood pressure, pulse oximetry and $EtCO_2$.
In Group A, inferior alveolar nerve block was given by Halstead technique using 2 ml of 0.5% bupivacaine. In Group M, mandibular nerve block was given by Gow-Gates or Vazirani-Akinosi technique using same drug and volume. The block was performed after induction and around 15 minutes before incision under aseptic precautions. Additional fentanyl was given intraoperatively when required.
Heart rate and mean arterial pressure were recorded at baseline and at different intraoperative and postoperative time intervals. Additional intraoperative fentanyl requirement, time to first additional fentanyl and adverse effects were recorded. Data were entered and analysed using suitable statistical software. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as number and percentage. Student t-test, Chi-square test or Fisher exact test were applied as appropriate. A p-value <0.05 was considered statistically significant.

Results

Table 1: Baseline demographic and operative profile of patients in both study groups

Variable	Group A (n=50)	Group M (n=50)	p-value
Age group, n (%)			0.64
18–35 years	22 (44%)	26 (52%)	
36–50 years	18 (36%)	17 (34%)	
51–65 years	10 (20%)	7 (14%)	
Gender, n (%)			0.39
Male	36 (72%)	32 (64%)	
Female	14 (28%)	18 (36%)	

BMI, mean ± SD, kg/m²	24.70 ± 3.46	25.18 ± 3.22	0.47
ASA grade, n (%)			0.42
ASA I	24 (48%)	20 (40%)	
ASA II	26 (52%)	30 (60%)	
Duration of surgery, mean ± SD, min	92.56 ± 14.72	95.38 ± 16.11	0.36

A total of 100 patients were included in the study with 50 patients in each group. In Group A, 22 patients (44%) were aged 18–35 years, 18 patients (36%) were aged 36–50 years and 10 patients (20%) were aged 51–65 years. In Group M, 26 patients (52%) were aged 18–35 years, 17 patients (34%) were aged 36–50 years and 7 patients (14%) were aged 51–65 years. The age distribution was comparable between both groups (p = 0.64). Male patients were more common in both groups. Group A had 36 males (72%) and 14 females (28%), while Group M had 32 males (64%) and 18 females (36%). The gender distribution was statistically comparable (p = 0.39). Mean BMI was 24.70 ± 3.46 kg/m² in Group A and 25.18 ± 3.22 kg/m² in Group M (p = 0.47). ASA grade distribution was also comparable between the groups (p = 0.42). The mean duration of surgery was 92.56 ± 14.72 minutes in Group A and 95.38 ± 16.11 minutes in Group M (p = 0.36).

Table 2: Comparison of intraoperative heart rate and mean arterial pressure at different time intervals

Time interval	Heart rate Group A, mean ± SD	Heart rate Group M, mean ± SD	p-value	MAP Group A, mean ± SD	MAP Group M, mean ± SD	p-value
0 min before induction	80.38 ± 9.02	82.10 ± 10.26	0.37	91.79 ± 8.60	95.20 ± 9.14	0.05
5 min after induction	85.74 ± 10.81	83.63 ± 9.94	0.31	88.46 ± 9.72	90.63 ± 8.68	0.24
10 min at time of block	84.29 ± 10.34	82.18 ± 9.47	0.28	90.18 ± 8.94	92.51 ± 8.27	0.17
15 min at incision	94.86 ± 12.18	86.97 ± 9.36	0.0004	94.92 ± 10.48	93.74 ± 8.53	0.53
30 min	92.41 ± 11.52	83.74 ± 8.92	0.0001	96.64 ± 9.83	90.86 ± 7.94	0.001
45 min	90.63 ± 10.74	82.85 ± 8.27	0.0001	95.73 ± 9.26	89.97 ± 7.48	0.0009
60 min	88.57 ± 9.96	81.94 ± 7.84	0.0004	92.84 ± 8.71	88.69 ± 7.12	0.01

The baseline intraoperative heart rate was 80.38 ± 9.02/min in Group A and 82.10 ± 10.26/min in Group M (p = 0.37). Heart rate at 5 minutes and 10 minutes was also comparable between the groups with p-values of 0.31 and 0.28 respectively. At 15 minutes, heart rate increased to 94.86 ± 12.18/min in Group A and 86.97 ± 9.36/min in Group M. This difference was statistically significant (p = 0.0004). Heart rate remained significantly higher in Group A at 30 minutes, 45 minutes and 60 minutes with p-values of 0.0001, 0.0001 and 0.0004 respectively. Baseline MAP was 91.79 ± 8.60 mmHg in Group A and 95.20 ± 9.14 mmHg in Group M (p = 0.05). MAP at 5 minutes, 10 minutes and 15 minutes was comparable between the groups. At 30 minutes, MAP was 96.64 ± 9.83 mmHg in Group A and 90.86 ± 7.94 mmHg in Group M (p = 0.001). At 45 minutes and 60 minutes also MAP was significantly higher in Group A with p-values of 0.0009 and 0.01 respectively.

Table 3: Comparison of postoperative heart rate and mean arterial pressure in both groups

Postoperative time	Heart rate Group A, mean ± SD	Heart rate Group M, mean ± SD	p-value	MAP Group A, mean ± SD	MAP Group M, mean ± SD	p-value
0 hour	88.46 ± 9.84	82.71 ± 8.63	0.002	96.82 ± 8.91	91.34 ± 7.86	0.001
30 min	90.73 ± 10.26	83.65 ± 8.94	0.004	98.57 ± 9.34	92.48 ± 8.12	0.0008
2 hours	92.38 ± 10.91	84.12 ± 9.26	0.0001	100.41 ± 9.76	93.17 ± 8.48	0.0001
4 hours	94.82 ± 11.48	85.63 ± 9.74	<0.0001	102.76 ± 10.32	94.85 ± 8.96	0.001
6 hours	96.17 ± 12.03	86.74 ± 9.88	<0.0001	104.28 ± 10.86	95.96 ± 9.17	0.0001

Postoperative heart rate was significantly lower in Group M at all recorded time intervals. At 0 hour, heart rate was 88.46 ± 9.84/min in Group A and 82.71 ± 8.63/min in Group M (p = 0.002). At 30 minutes, it was 90.73 ± 10.26/min in Group A and 83.65 ± 8.94/min in Group M (p = 0.004). At 2 hours, 4 hours and 6 hours, heart rate remained significantly higher in Group A with p-values of 0.0001, <0.0001 and <0.0001 respectively.

Postoperative MAP was also significantly lower in Group M at all observed intervals. At 0 hour, MAP was 96.82 ± 8.91 mmHg in Group A and 91.34 ± 7.86 mmHg in Group M (p = 0.001). At 30 minutes, MAP was 98.57 ± 9.34 mmHg in Group A and 92.48 ± 8.12 mmHg in Group M (p = 0.0008). At 2 hours, 4 hours and 6 hours, the MAP remained significantly higher in Group A with p-values of 0.0001, 0.001 and 0.0001 respectively.

Table 4: Comparison of intraoperative rescue fentanyl requirement in both groups

Analgesic variable	Group A, mean ± SD	Group M, mean ± SD	p-value
Additional IV fentanyl dose intraoperatively, µg	75.80 ± 17.40	50.20 ± 13.65	<0.0001
Time to first additional IV fentanyl from time of block, min	23.10 ± 6.25	36.85 ± 8.40	<0.0001

The mean additional intraoperative fentanyl requirement was 75.80 ± 17.40 µg in Group A and 50.20 ± 13.65 µg in Group M. This difference was statistically highly significant ($p < 0.0001$). The time to first additional IV fentanyl from the time of block was 23.10 ± 6.25 minutes in Group A and 36.85 ± 8.40 minutes in Group M. This difference was also statistically highly significant ($p < 0.0001$).

Table 5: Distribution of adverse effects in both study groups

Adverse effect	Group A, n (%)	Group M, n (%)	p-value
Nausea and vomiting	6 (12%)	4 (8%)	0.66
Hypotension	3 (6%)	5 (10%)	
Bradycardia	2 (4%)	1 (2%)	
Others	1 (2%)	2 (4%)	

Nausea and vomiting were observed in 6 patients (12%) in Group A and 4 patients (8%) in Group M. Hypotension was seen in 3 patients (6%) in Group A and 5 patients (10%) in Group M. Bradycardia occurred in 2 patients (4%) in Group A and 1 patient (2%) in Group M. Other adverse effects were reported in 1 patient (2%) in Group A and 2 patients (4%) in Group M. The overall distribution of adverse effects was comparable between the groups ($p = 0.66$).

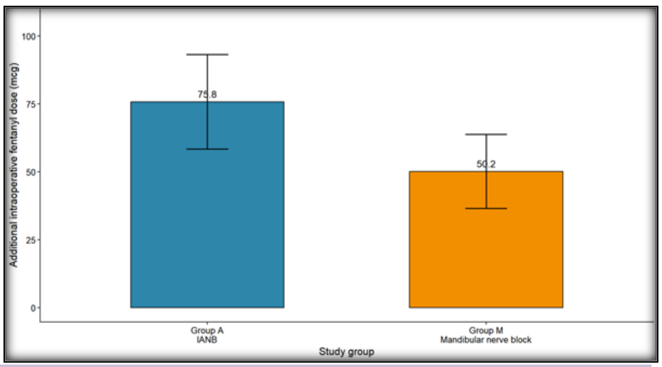

Figure 1: Comparison of mean additional intraoperative fentanyl requirement between inferior alveolar nerve block and mandibular nerve block

Discussion

In the present randomized comparative study, 100 patients undergoing elective unilateral mandibular fracture surgery under general anaesthesia were studied. Group A received inferior alveolar nerve block and Group M received mandibular nerve block. Both groups were comparable for age, gender, BMI, ASA grade and duration of surgery [Table 1]. This baseline similarity is important because age, physical status and operative duration can affect intraoperative haemodynamic response and postoperative analgesic requirement. Similar baseline matching was also reported by Venkatraman et al. in mandibular fracture surgery and by Shetmahajan et al. in maxillofacial surgery under general anaesthesia.[6,8]

Pain after mandibular fracture surgery is mainly because of fracture manipulation, periosteal stimulation, soft tissue handling and fixation. Under general anaesthesia this pain response may not be felt by the patient but it is reflected as tachycardia, rise in blood pressure and increased opioid requirement. Modern perioperative analgesia is moving towards opioid sparing technique because excessive opioid use may cause nausea, vomiting, sedation, respiratory depression and delayed recovery.[9] Nerve blocks are useful in this setting as they block afferent nociceptive input and reduce central opioid need.[10]

In the present study, baseline intraoperative heart rate was comparable between the groups. Heart rate at 0, 5 and 10 minutes did not show significant difference. However from incision time onwards, heart rate was significantly lower in Group M. At 15 minutes, mean heart rate was 94.86 ± 12.18/min in Group A compared to 86.97 ± 9.36/min in Group M ($p = 0.0004$). The difference remained significant at 30, 45 and 60 minutes [Table 2]. This suggests that mandibular nerve block gave better intraoperative analgesic cover after surgical stimulus started. The more proximal nature of mandibular nerve block may explain this finding because it blocks a wider mandibular nerve distribution than the conventional inferior alveolar block.[11]

The mean arterial pressure also showed similar trend. Baseline and early intraoperative MAP values were largely comparable. At 30 minutes MAP was 96.64 ± 9.83 mmHg in Group A and 90.86 ± 7.94 mmHg in Group M ($p = 0.001$). At 45 minutes and 60 minutes also MAP remained significantly lower in Group M [Table 2]. These findings support that mandibular nerve block reduced the sympathetic response during the active surgical period. Shetmahajan et al. also reported that IANB reduced haemodynamic response during maxillofacial cancer surgery. In their study mean maximum heart rate during primary tumour excision was 82/min in the IANB arm and 99/min in control arm and maximum mean blood pressure was 88 mmHg and 101 mmHg respectively.[8] Our study goes one step further as it compares IANB with a more proximal mandibular nerve block rather than comparing block with no block.

Postoperative haemodynamic findings also supported better early analgesia in Group M. At 0 hour, postoperative heart rate was 88.46 ± 9.84/min in Group A and 82.71 ± 8.63/min in Group M ($p = 0.002$). At 2 hours, it was 92.38 ± 10.91/min and 84.12 ± 9.26/min respectively ($p = 0.0001$). The difference remained significant till 6 hours [Table 3]. Postoperative MAP also remained significantly lower in Group M at all observed time points up to 6 hours. At 6 hours MAP was 104.28 ± 10.86 mmHg in Group A and 95.96 ± 9.17 mmHg in Group M ($p = 0.0001$). This shows that the analgesic benefit of mandibular nerve block was not only intraoperative but also extended into the early postoperative period.

The most direct analgesic outcome in this study was intraoperative fentanyl requirement. Group A required 75.80 ± 17.40 µg additional IV fentanyl while Group M required 50.20 ± 13.65 µg ($p < 0.0001$). The time to first additional IV fentanyl was also longer in Group M, 36.85 ± 8.40 minutes compared to

23.10 ± 6.25 minutes in Group A ($p < 0.0001$) [Table 4]. This is a clinically meaningful finding because it shows both lower opioid dose and longer pain free interval after the block. Venkatraman et al. studied 60 patients undergoing unilateral mandibular fracture surgery and reported that pre-emptive ultrasound guided mandibular nerve block reduced intraoperative opioid use and prolonged postoperative analgesia.[6] The direction of finding is similar to our study although our study compared two block techniques.

Elsayed et al. studied pre-emptive IANB in mandibular fracture surgery and reported significantly lower intraoperative fentanyl requirement and lower postoperative pethidine consumption in the IANB group compared with control.[12] In their study postoperative pain benefit was mainly seen during the first 6 hours. Our postoperative haemodynamic findings also show maximum separation between groups during the first 6 hours. Mesgarzadeh et al. studied bilateral mental nerve block with bupivacaine in mandibular parasymphysis fracture and found significantly lower opioid need in the block group. First opioid requirement was reported in 0–2 hours in control group and 2–4 hours in block group.[4] These studies support the opioid sparing effect of regional blocks in mandibular fracture surgery.

The difference between the two blocks may be anatomical. Inferior alveolar nerve block deposits local anaesthetic near the inferior alveolar nerve before it enters the mandibular canal. It is useful and familiar but its spread is limited mainly to inferior alveolar nerve territory. Mandibular nerve block by Gow-Gates or Vazirani-Akinosi approach targets the mandibular division of trigeminal nerve at a higher level. It may block inferior alveolar, lingual, auriculotemporal, mylohyoid and buccal sensory contribution more effectively when the block is successful. Wang et al. described that local anaesthesia success in oral and maxillofacial surgery varies according to anatomy, technique and local spread.[13] Lee and Yang also discussed that conventional IANB may fail because of anatomical and technical reasons and alternative mandibular techniques may help in such situations.[14]

The available dental anaesthesia literature also supports the better coverage of higher mandibular block techniques. Sarfaraz et al. in a systematic quantitative review reported higher anaesthetic efficacy of Gow-Gates mandibular nerve block compared with inferior alveolar nerve block in mandibular teeth with irreversible pulpitis.[15] Nakkeeran et al. found that Vazirani-Akinosi block had higher success and lower pain perception compared with conventional IANB when performed by beginners.[16] Jendi et al. also described Vazirani-Akinosi nerve block as a reliable technique for mandibular anaesthesia especially when conventional techniques are difficult.[17] Although these studies are mainly dental and not fracture surgery studies, they support the anatomical reasoning behind the better analgesic profile seen in Group M.

Yu et al. in a meta-analysis of mandibular third molar surgery reported that Gow-Gates and Vazirani-Akinosi techniques had lower risk of positive aspiration compared with conventional IANB. The Gow-Gates technique showed higher success while Vazirani-Akinosi had faster onset in some included studies.[18] This is relevant to the present study because safety and technical success are both important in trauma patients. In mandibular fracture cases mouth opening may be limited and the local anatomy may be distorted. A block which covers a wider field may reduce the need for repeated supplementation. However, mandibular nerve block is technically more demanding and needs proper training.

In our study adverse effects were comparable between groups. Nausea and vomiting occurred in 12% patients in Group A and 8% in Group M. Hypotension occurred in 6% and 10% respectively. Bradycardia was seen in 4% and 2% respectively. The overall difference was not significant ($p = 0.66$) [Table 5]. This shows that mandibular nerve block did not increase short term adverse effects in the present sample. The lower fentanyl use in Group M may be useful because opioid related side effects are clinically important in maxillofacial patients where airway safety, vomiting and sedation are important concerns.[9,10]

The present study has few limitations. Pain score values and total 24 hour rescue analgesic consumption were not included in the final condensed tables, so the postoperative analgesic interpretation is mainly based on haemodynamic parameters and fentanyl requirement. The study was single centre and block success may depend on operator skill. The mandibular nerve block group included Gow-Gates or Vazirani-Akinosi technique according to anatomical suitability, so both techniques were not separately analysed. Ultrasound guidance was not used. Still, the study gives useful practical evidence that mandibular nerve block provides better perioperative analgesic profile than inferior alveolar nerve block in elective unilateral mandibular fracture surgery under general anaesthesia.

Overall, mandibular nerve block showed better intraoperative and early postoperative analgesic efficacy than inferior alveolar nerve block. It was associated with lower heart rate and MAP after surgical stimulation, lower additional fentanyl requirement and delayed first fentanyl need. Adverse effects were similar in both groups. Therefore mandibular nerve block can be considered a useful component of multimodal analgesia in elective unilateral mandibular fracture surgery, provided the clinician is trained in the technique.

Conclusion

Mandibular nerve block was more effective than inferior alveolar nerve block in patients undergoing elective unilateral mandibular fracture surgery under general anaesthesia. It provided better control of intraoperative and early postoperative heart rate and mean arterial pressure. It also reduced additional intraoperative fentanyl requirement and prolonged the time to first rescue fentanyl. The incidence of adverse effects was similar in both groups. Mandibular nerve block can therefore be considered as a useful component of multimodal analgesia for unilateral mandibular fracture surgery, when performed by a trained anaesthesiologist.

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Conflicts of interest

There are no conflicts of interest.

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