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Original Research Article

Efficacy of the Combination of Dexmedetomidine and Ketamine versus Ketamine alone for Intra-Operative Sedation in Pediatric Patients Undergoing Upper Limb Surgeries Under Brachial Plexus Block

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Abstract:

Background: Upper limb nerve blocks and perineural catheter infusions can provide adequate and lasting analgesia, which is crucial for upper limb surgery. In nerve blocks the use of ultrasound-guided anaesthesia has shown significant success. There has been increasing interest in using sub-anesthetic doses of ketamine and administering it as an infusion in conjunction with sub-anesthetic doses of medications like propofol (1 mg/kg) and dexmedetomidine (0.5 mg/kg) due to its benefits of effective analgesia, lack of respiratory depression, and bronchodilation, which have lessened the negative effects of ketamine. Dexmedetomidine has good analgesic qualities in addition to its sedative effects, although it can also cause bradycardia and hypotension. Ketamine's sympathomimetic qualities cause it to raise heart rate and blood pressure while maintaining respiratory activity. Hence these two drugs balance each other because of their opposing actions when used together.

Aim: To analyze efficacy of the combination of Dexmedetomidine and Ketamine versus Ketamine alone for intraoperative sedation in pediatric patients undergoing upper limb surgeries under brachial plexus block.

Method: Thorough pre-anaesthetic evaluation was performed, and necessary investigations were conducted. Moreover, the written consent was obtained from the parents of the children. Children between age group 5 to 12 years. The written informed consent was obtained from 60 patients aged between 5 to 12 years who were scheduled for upper limb surgeries under brachial plexus block. They were divided randomly into two groups to receive either Ketamine (Group K) or combination of Dexmedetomidine and Ketamine (Group KD). Separate samples Haemodynamic parameters and other continuous variables were compared using the t-test. The significance test for categorical variables was conducted using Fisher's exact and Chi-square tests. SPSS software for Windows, version 30.0, was used to analyse the data after it was loaded into a Microsoft Excel sheet.

Results: Since we combined analgosedation with continuous infusion, the hemodynamic parameters HR, SBP, DBP, RR, and SpO_2 did not exhibit a statistically significant difference between the two groups ($p > 0.05$). The quality of sedation of Ketamine group was found excellent for 5 patients and good for 24 and poor in 1 patient whereas, for Ketamine plus Dexmedetomidine group, it was excellent for 28 patients good for 2 patients. It shows, there was significant association between quality of sedation and groups ($p<0.05$). Quality of sedation was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group. Also, duration of sedation was significantly more in Ketamine plus Dexmedetomidine group, with lesser adverse effects.

Conclusion: Under the supraclavicular brachial block, pre-emptive analgosedation with Ketamine plus Dexmedetomidine can be utilised in upper limb orthopaedic procedures in a safe and efficient manner. Compared to Ketamine alone Ketamine plus Dexmedetomidine offers superior analgesia, better quality and duration of sedation with minimal hemodynamic alterations and adverse effects.

Keywords: Upper Limb Surgery, Brachial Plexus Block, Ketamine, Dexmedetomidine

Introduction

Upper limb nerve blocks and perineural catheter infusions can provide adequate and lasting analgesia, which is crucial for upper limb surgery. In nerve blocks the use of ultrasound-guided anaesthesia has shown significant success [1]. With the availability of numerous anaesthetic medications in daily practice, procedural sedation during regional anaesthesia has always been difficult for the

anaesthesiologist [2]. Breakthrough discomfort has been prevented by the increased use of propofol and dexmedetomidine for sedation during regional anaesthesia [3]. More opioids must be administered intraoperatively to address breakthrough pain since it results from nerve fibres that have been spared in a localised blockade [4]. There is insufficient evidence to support balanced sedation during such surgeries in the age of opioid-free anaesthesia [5].

There has been increasing interest in using sub-anesthetic doses of ketamine and administering it as an infusion in conjunction with sub-anesthetic doses of medications like propofol (1 mg/kg) and dexmedetomidine (0.5 mg/kg) due to its benefits of effective analgesia, lack of respiratory depression, and bronchodilation, which have lessened the negative effects of ketamine [6]. Propofol can nonetheless result in hypotension and dose-dependent respiratory depression even though it is a short-acting medication with a good recovery profile and anti-emetic qualities [7]. Dexmedetomidine has good analgesic qualities in addition to its sedative effects, although it can also cause bradycardia and hypotension. Ketamine's sympathomimetic qualities cause it to raise heart rate and blood pressure while maintaining respiratory activity [8]. However, unwanted adverse effects of ketamine include sympathetic stimulation, treatment-emergent delirium, and a longer recovery period with standard dosages [9].

The ketamine-dexmedetomidine (ketadex) and ketamine-propofol (ketofol) combinations may be useful in delivering adequate sedation and anaesthesia induction and maintenance, while preserving haemodynamic stability and minimising possible adverse effects of each medication, as ketamine has opposing cardiovascular and respiratory effects on both dexmedetomidine and propofol [10,11]. These two combinations have been the subject of numerous researches comparing them in the paediatric population, and they have lately begun to acquire traction in the adult population as well [12]. There has been a lot of study comparing them in terms of sedation/anesthetic properties and possible adverse effects, but none have compared between ketamine alone versus combination of ketamine with dexmedetomidine. Thus, the proposed study is focused on analysing the efficacy of the combination of Dexmedetomidine and Ketamine versus Ketamine alone for intraoperative sedation in pediatric patients undergoing upper limb surgeries under brachial plexus block.

Aim: To analyze efficacy of the combination of Dexmedetomidine and Ketamine versus Ketamine alone for intraoperative sedation in pediatric patients undergoing upper limb surgeries under brachial plexus block.

Material and Method

Thorough pre-anaesthetic evaluation was performed, and necessary investigations were conducted. Moreover, the written consent was obtained from the parents of the children.

Inclusion criteria: Children between age group 5 to 12 years.

Exclusion criteria: Children with respiratory disorder, psychiatric disorder, allergy to any medicine used in the study and congenital heart disease.

Design: There was a written informed consent was obtained. 60 patients aged between 5 to 12 years were scheduled for upper limb surgeries under brachial plexus block were divided randomly into two groups to receive either Ketamine (Group K) or combination of Dexmedetomidine and Ketamine (Group KD). The group K patients have received 1mg/kg of Ketamine as IV loading dose followed by 0.25mg/min IV continuous infusion throughout the duration of surgery. Apart from this, Group Ketamine plus Dexmedetomidine patients have received 1mcg/kg of Dexmedetomidine as slow IV loading dose over 10 mins followed by 0.2mcg/kg/hr continuous infusion throughout the duration of surgery along with 1mg/kg of Ketamine as IV loading dose followed by 0.25mg/min IV continuous infusion throughout the duration of surgery. Both the group of patients have received Midazolam IV 0.25mg/kg as premedication. The parameters that were going to be assessed involve the quality of sedation, duration of sedation, hemodynamic parameters and adverse effects if any.

Statistical Analysis: Separate samples Haemodynamic parameters and other continuous variables were compared using the t-test. The significance test for categorical variables was conducted using Fisher's exact and Chi-square tests. SPSS software for Windows, version 30.0, was used to analyse the data after it was loaded into a Microsoft Excel sheet.

Results

Table 1: Mean SBP

	Ketamine	Ketamine plus Dexmedetomidine	p-value
Mean SBP	114 ± 5	109 ± 4	0.35

According to table 1, the mean SBP of Ketamine group was 114 ± 5 and Ketamine plus

Dexmedetomidine group was 109 ± 4, showing no significant difference in SBP between the groups (p>0.05).

Table 2: Mean DBP

	Ketamine	Ketamine plus Dexmedetomidine	p-value
Mean DBP	80 ± 2.1	84 ± 3	0.21

According to table 2, the mean DBP of Ketamine group was 80 ± 2.1 and Ketamine plus Dexmedetomidine group was 84 ± 3, showing no significant difference in DBP between the groups (p>0.05).

Table 3: Mean pulse

	Ketamine	**Ketamine plus Dexmedetomidine**	**p-value**
Mean pulse	95 ± 6	84 ± 8	0.12

According to table 3, the mean Pulse of Ketamine group was 95 ± 6 and Ketamine plus Dexmedetomidine group was 84 ± 8, showing no significant difference in pulse rate between the groups (p>0.05).

Table 4: ECG

ECG	**Ketamine**	**Ketamine plus Dexmedetomidine**	**p-value**
SR	30	30	1.0
Non-SR	0	0	

As per the outcome of table 4, all 30 patients of Ketamine and Ketamine plus Dexmedetomidine groups showed SR on ECG, showing no significant association (p>0.05).

Table 5: Mean SpO2

	Ketamine	**Ketamine plus Dexmedetomidine**	**p-value**
Mean SpO_2	98 ± 0.9	99 ± 0.1	0.11

According to table 5, the mean SpO_2 of Ketamine group was 98 ± 0.9 and Ketamine plus Dexmedetomidine group was 99 ± 0.1, showing no significant difference in SpO_2 between the groups (p>0.05).

Table 6: Mean RR

	Ketamine	**Ketamine plus Dexmedetomidine**	**p-value**
Mean RR	21 ± 1.1	22 ± 1.6	0.45

According to table 6, the mean RR of Ketamine group was 21 ± 1.1 and Ketamine plus Dexmedetomidine group was 22 ± 1.6, showing no significant difference in RR between the groups (p>0.05).

Table 7: Duration of Sedation

	Ketamine	**Ketamine plus Dexmedetomidine**	**p-value**
Duration of Sedation (minutes)	14.2 ± 1.1	18.1 ± 1.6	0.03

According to table 7, the mean duration of sedation of Ketamine group was 14.2 ± 1.1 minutes and Ketamine plus Dexmedetomidine group was 18.1 ± 1.6 minutes, showing significant difference in duration of sedation between the groups (p<0.05). It was significantly higher in Ketamine plus Dexmedetomidine group.

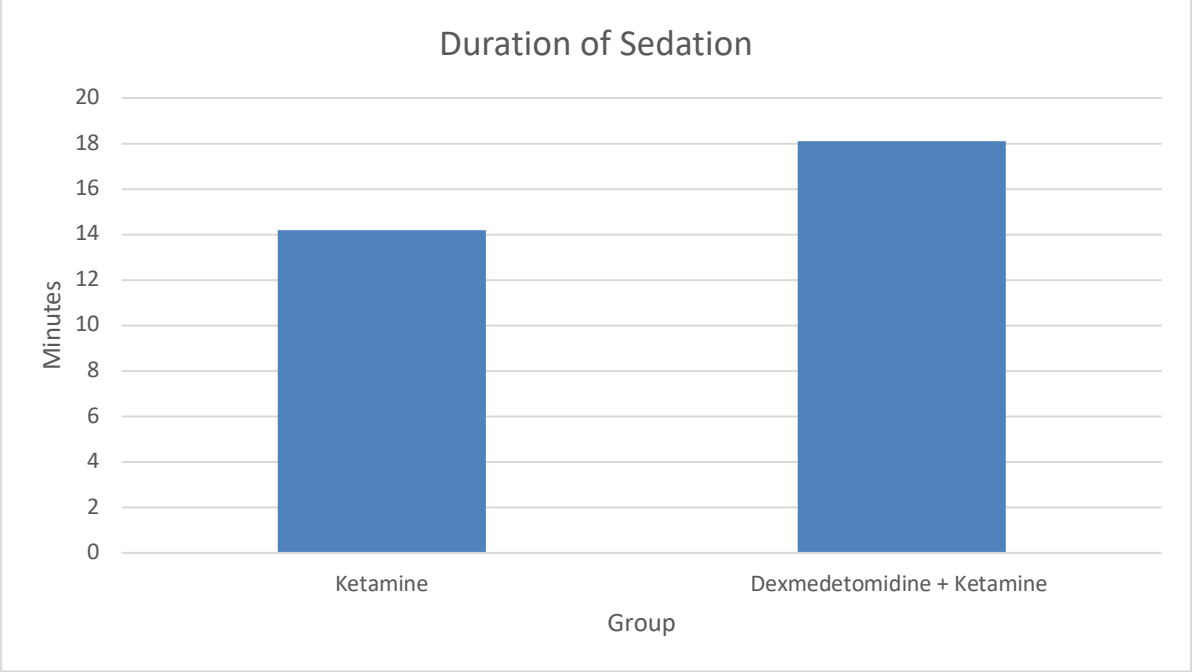

Figure 1: Duration of Sedation

Table 8: Children's hospital of Wiscosin Sedation scale

	Ketamine	Ketamine plus Dexmedetomidine	p-value
Children's hospital of Wiscosin Sedation scale	5.1 ± 1.2	2.7 ± 0.6	0.02

According to table 8, the mean score of Children's hospital of Wiscosin Sedation scale of Ketamine group was 5.1 ± 1.2 and Ketamine plus Dexmedetomidine group was 2.7 ± 0.6. There was significant difference in Children's hospital of Wiscosin Sedation scale between 2 groups ($p<0.05$). Children's hospital of Wiscosin Sedation scale was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group.

Table 9: Modified Aldrete recovery score

	Ketamine	Ketamine plus Dexmedetomidine	p-value
Modified Aldrete recovery score	6 ± 1.6	9 ± 0.4	0.03

According to table 9, the Modified Aldrete recovery score of Ketamine group was 6.0 ± 1.6, and Ketamine plus Dexmedetomidine group was 9.0 ± 0.4. It shows, there was significant difference in Modified Aldrete recovery score between the 2 groups ($p<0.05$). Modified Aldrete recovery score was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group.

Table 10: Quality of Sedation

Quality of Sedation	Ketamine	Ketamine plus Dexmedetomidine	p-value
Excellent	5	28	0.03
Good	24	2	
Poor	1	0	

According to table 10, the quality of sedation of Ketamine group was found excellent for 5 patients and good for 24 and poor in 1 patient. Whereas, for Ketamine plus Dexmedetomidine group, it was excellent for 28 patients good for 2 patients. It shows, there was significant association between quality of sedation and groups ($p<0.05$). Quality of sedation was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group.

Figure 2: Quality of Sedation

Table 11: Side Effects

Side Effects	Ketamine	Ketamine plus Dexmedetomidine
Nausea vomiting	3	1
Hypotension	0	1
Hypertension	4	0
Bradycardia	1	3

As per table 11, low incidence of side effects was observed in both the groups.

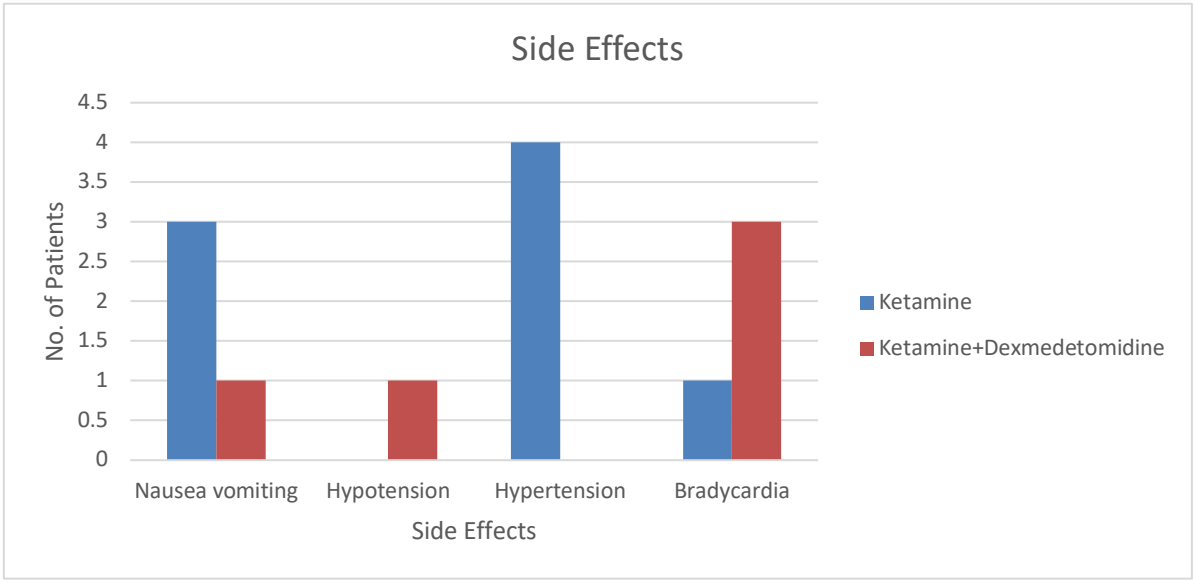

Figure 3: Side Effects

Discussion

In the traditional method of providing surgical anaesthesia through regional anaesthesia, moderate sedation is required to increase the patient's acceptance of regional anaesthesia.

According to analysis above, the mean SBP of Ketamine group was 114 ± 5 and Ketamine plus Dexmedetomidine group was 109 ± 4 ($p>0.05$). The mean DBP of Ketamine group was 80 ± 2.1 and Ketamine plus Dexmedetomidine group was 84 ± 3 ($p>0.05$). Moreover, the mean Pulse of Ketamine group was 95 ± 6 and Ketamine plus Dexmedetomidine group was 84 ± 8 ($p>0.05$). Apart from this, all 30 patients of Ketamine and Ketamine plus Dexmedetomidine groups had SR on ECG. In

addition to this, the mean SpO2 of Ketamine group was 98 ± 0.9 and Ketamine plus Dexmedetomidine group was 99 ± 0.1 (p>0.05) and RR of Ketamine group was 21 ± 1.1 and Ketamine plus Dexmedetomidine group was 22 ± 1.6 (p>0.05). According to study outcome of El-Rrouby et al., (2024) [13], the mean DBP was 64.96 ± 12.93 for Ketamine plus Dexmedetomidine group and 65.85 ± 16.50 for D group (p>.05) and SBP was 95.35 ± 16.18 for Ketamine plus Dexmedetomidine group and 98.46 ± 18.67 for D group (p>.05). Similarly, the mean SpO2 for Ketamine plus Dexmedetomidine group was 98.08 ± 0.98 and for D group was 98.04 ± 0.82 (p>.05). Since we combined analgosedation with continuous infusion, the hemodynamic parameters HR, SBP, DBP, RR, and SpO 2 did not exhibit a statistically significant difference between the two groups (p>0.05).

The mean duration of sedation of Ketamine group was 14.2 ± 1.1 minutes, and Ketamine plus Dexmedetomidine group was 18.1 ± 1.6 minutes, showing significant difference in duration of sedation between the groups (p<0.05). Similarly, Kakhki et al (2023) [14] found that the duration of sedation was 14.35 and 9.7 minutes in ketamine and dexmedetomidine groups, respectively (p=0.023). This shows that duration of sedation was significantly more in Ketamine plus Dexmedetomidine group.

Moreover, the current study has analyzed the mean score of Children's hospital of Wiscosin Sedation scale of Ketamine group was 5.1 ± 1.2 and Ketamine plus Dexmedetomidine group was 2.7 ± 0.6. There was significant difference in Children's hospital of Wiscosin Sedation scale between 2 groups (p<0.05). Modified Aldrete recovery score of Ketamine group was 6.0 ± 1.6, and Ketamine plus Dexmedetomidine group was 9.0 ± 0.4. It shows, there was significant difference in Modified Aldrete recovery score between the 2 groups (p<0.05). Modified Aldrete recovery score was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group.

Additionally, the quality of sedation of Ketamine group was found excellent for 5 patients and good for 24 and poor in 1 patient, whereas for Ketamine plus Dexmedetomidine group, it was excellent for 28 patients good for 2 patients. Quality of sedation was significantly better for Ketamine plus Dexmedetomidine group as compared to Ketamine group, showing better sedation quality in Ketamine plus Dexmedetomidine group. Apart from this, the study of Harikrishnan (et al., 2023) [6] suggested that the mean Aldrete score was significantly higher among Group receiving Ketamine plus Dexmedetomidine as compared to group receiving KP (p<.05). Further, the studies by Arun et al (2022) [15] and Joshi et al. (2025) [16] also found that sedation score was significantly better for group receiving Ketamine as compared to group receiving only D (p<.05). Finally, a low incidence of side effects was observed in both the groups which is similar to the findings of Gupta et al (2022) [17].

From the analysis, it has been carried out that Ketamine was first intended to be used as the only anaesthetic drug that produced analgesia, forgetfulness, and loss of consciousness. It was regarded as safe, easy, and effective. When ketamine is combined with either propofol or dexmedetomidine, smaller dosages can be used, synergism is added, and adverse effects are reduced.

Conclusion

Under the supraclavicular brachial block, pre-emptive analgosedation with Ketamine plus Dexmedetomidine can be utilised in upper limb orthopaedic procedures in a safe and efficient manner. Compared to Ketamine alone Ketamine plus Dexmedetomidine offers superior analgesia, better quality and duration of sedation with minimal hemodynamic alterations and adverse effects.

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