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Comparison of Lidocaine Alone Versus Lidocaine with Dexmedetomidine for Intravenous Regional Anesthesia

Muhammad Mansoor Younas [1], ***Muhammad Amjad Khan*** [1], ***Ayesha Shafqat*** [1], ***Rimsha Zafar*** [1], ***Amina Majeed*** [1], ***Sumayya Tariq*** [2]

[1]*Department of Anesthesia, Fatima Memorial Hospital, Lahore,* [2] *Department of Anesthesia, Sharif Medical City Hospital, Lahore, Pakistan.*

ABSTRACT

Background: Intravenous regional anesthesia (IVRA) is an efficient method of short limb surgery, but often provides limited pain relief in the postoperative period. Dexmedetomidine is an α2-adrenergic agonist that can potentially improve local anesthetic effects, but there is limited evidence in Pakistan because of its previous unavailability. This study aimed to compare lidocaine alone and lidocaine combined with dexmedetomidine IVRA in below-elbow surgery.

Methods: This randomized controlled study was conducted at Fatima Memorial Hospital, Lahore, from September 3, 2024, to March 2, 2025. 90 ASA I-II patients, aged 18-60 years, who were undergoing elective upper limb surgery, were randomly assigned to two groups. Group A received regional anesthesia with 40ml of lignocaine 0.5%, while Group B received (Bier's Block) the same lignocaine with 0.5μg/kg dexmedetomidine. Tourniquet pain after 2 hours and anesthesia duration were noted. Data were analysed using SPSS v25.0 with a p-value ≤0.05 as statistically significant.

Results: The Lidocaine plus Dexmedetomidine group showed significantly lower mean pain scores (1.49 ± 0.506) compared to the Lidocaine alone group (2.78 ± 0.704) with a p-value of 0.001. The duration of analgesia was significantly extended in the combination group (190.82 ± 33.71 minutes) when compared to the Lidocaine-alone group (145.73 ± 13.23 minutes), also with a p-value of 0.001.

Conclusion: The combination of dexmedetomidine with lidocaine during IVRA is highly effective in enhancing postoperative analgesia and pain reduction that may lead to an efficient intervention to perform perioperative pain management during upper limb surgery.

Keywords: Cholelithiasis, Gallbladder Diseases, Postoperative Complications, Outpatients, Cross-Sectional Studies, Prevalence.

***Corresponding Author:** Muhammad Mansoor Younas
Email: muhammmadmansooryounas@gmail.com

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INTRODUCTION

Intravenous regional anesthesia (IVRA) effectively anesthetizes limbs by applying a tourniquet and injecting local anesthetic below it to target major nerves [1]. However, despite its popularity, IVRA is often limited by tourniquet pain, anesthetic toxicity, and limited postoperative relief, with a risk of compartment syndrome [2]. Lidocaine is the most commonly used agent for IVRA, but its relatively short duration and poor postoperative analgesia have prompted investigation into various adjuvants [3].

Alpha2-adrenergic receptor agonists are gaining attention for their sedative, analgesic, and perioperative effects, including cardiovascular stabilization. They decrease the reliance on general anesthesia and extend the local impact in regional blocks [4]. Clonidine-enhanced local anesthetics provide better pain relief in spinal, epidural, or nerve blocks compared to plain solutions [5]. Dexmedetomidine, a highly selective 2-adrenergic agonist with sedative and analgesic effects, has been considered to increase local anesthetic potential [6]. The use of dexmedetomidine with local anesthetics has been found to increase the length of sensory block and the quality of analgesia in the postoperative period in regional anesthesia methods [7]. It has been demonstrated that adding dexmedetomidine to lidocaine in IVRA resulted in less pain during tourniquet and longer-lasting analgesia [8].

However, the evidence on an international scale is still limited and inconsistent, and there are few local studies due to the absence of dexmedetomidine previously in Pakistan. The absence of local data presents a significant gap in evidence to improve the perioperative management of pain with IVRA. Due to the potential advantages of dexmedetomidine, it is necessary to evaluate the effectiveness and safety of this drug in combination with local anesthesia in clinical practice [9].

Therefore, the objective of this study was to compare the effectiveness of lidocaine and lidocaine with dexmedetomidine in the use of IVRA in patients with below-elbow surgery, which may help inform best practices. This study also aimed to evaluate the impact of adding dexmedetomidine on the incidence and severity of tourniquet-related pain during and after surgery.

METHODS

This randomized control study was conducted in the Department of Anesthesiology at Fatima Memorial Hospital, Lahore, from September 3, 2024, to March 2, 2025 (ref FMH-IRB-1566). A total of 90 patients were included in the study, with 45 patients in each group. The sample size was calculated using OpenEpi version 3.0.0 (released 2013, Atlanta, GA, USA).

The inclusion criteria were patients aged between 18 and 60 years, of either gender, classified as ASA-I or ASA-II, and undergoing elective upper limb surgery with an expected duration of less than 45 minutes. Patients were excluded if they refused to participate, had a history of sleep apnea, were classified as ASA-III or ASA-IV, had a difficult airway, were obese (BMI >30), had second-degree or third-degree heart block, or had uncontrolled hypertension as documented in their medical records.

Patients were randomly assigned to Group A (lidocaine alone) or Group B (lidocaine with dexmedetomidine) using the lottery method. Allocation concealment was achieved by having each patient draw a sealed envelope. Two intravenous lines were secured: one with an 18-G cannula for lactated Ringer's solution in the non-surgical limb, and another in the surgical limb for study drug administration. Group A received a Bier's Block with 40 ml of preservative-free 0.5% lignocaine, while Group B received the same lignocaine dose with 0.5 µg/kg of dexmedetomidine added. The surgical limb's intravenous line was removed before surgery began. Intraoperative anesthesia was assessed using the Visual Analog Scale (VAS), while tourniquet pain was checked postoperatively after two hours. All information was documented in a structured form. Data analysis in this study utilized SPSS version 26.0 with $p \leq 0.05$ as significant.

RESULTS

Table 1: Comparison of the Distribution of Different Variables Between Groups

Variables		Groups			
		Lidocaine alone Group A	Lidocaine plus Dexmedetomidine Group B	Test value	p-value
Gender	Male	26(57.8%)	24(53.3%)	$\chi^2 = 0.180$	
	Female	19(42.2%)	21(46.7%)		0.671
Age groups	18-30 years	14(31.1%)	15(33.3%)	$\chi^2 = 0.158$	0.924
	31-45 years	25(55.6%)	23(51.1%)		
	46-60 years	6(13.3%)	7(15.6%)		
	Mean±SD	35.56±9.82	34.38±10.78	t =0.541	0.590
BMI (kg/m^2)	Normal	28(62.2%)	31(68.9%)	$\chi^2 = 0.654$	0.721
	Overweight	14(31.1%)	12(26.7%)		
	Obese	3(6.7%)	2(4.4%)		
	Mean±SD	27.96±1.37	27.97±1.46	t = -0.032	0.975

S.D = Standard Deviation, % = Percentage, BMI = Basal Metabolic Index

In this study, 90 patients (45 in each group), with one group receiving lidocaine alone and the other receiving lidocaine with dexmedetomidine, were enrolled. Significant differences based on gender, age, and BMI were observed in both duration of analgesia and pain scores among groups, with p-values less than 0.05. **Table 1** compares the distribution of different variables between the two groups.

Table 2: Comparison of Outcomes Between Groups

Outcomes	Groups			p-value
	Lidocaine alone Mean ± SD	Lidocaine plus Dexmedetomidine Mean ± SD	Test value	
Mean pain score (VAS)	2.78±0.704	1.49±0.506	t = 11.50	0.001
Mean duration of analgesia (minutes)	145.73±13.23	190.82±33.71	t = -8.62	0.001

S.D = Standard Deviation, % = Percentage, BMI = Basal Metabolic Index, VAS = Visual Analog Scale, p-value = <0.05 is significant

Group A had 26(57.8%) males and 19(42.2%) females, while Group B had 24(53.3%) males and 21(46.7%) females. The mean age was 35.56±9.818 years for Group A and 34.38±10.781 years for Group B. In Group A, 14 (31.1%) were aged 18-30 years, 25 (55.6%) were aged 31-45 years, and 6 (13.3%) were aged 46-60 years; in Group B, these percentages were 15 (33.3%), 23 (51.1%), and 7 (15.6%), respectively. The mean BMI was 27.96±1.37 kg/m^2 for Group A and 27.97±1.46 kg/m for Group B, with 28 (62.2%) of Group A patient's being of normal weight, 14 (31.1%) overweight, and 3 (6.7%) obese, and 31 (68.9%), 12 (26.7%), and 2 (4.4%) respectively in Group-B. Comparison of outcomes between the two groups is demonstrated in **Table 2.**

Table 3: Stratification of Mean Pain Score (VAS) Between Groups for Different Variables

Variables	Groups			
	Lidocaine alone Mean ± SD	Lidocaine plus Dexmedetomidine Mean ± SD	Test value	p-value
Gender				
Male	2.69±0.679	1.42±0.504	9.184	0.001
Female	2.89±0.737	1.57±0.507	6.900	
Age groups				
18-30 years	2.71±0.726	1.40±0.507	4.734	
31-45 years	2.64±0.638	1.43±0.507	8.265	0.001
46-60 years	3.50±0.548	1.86±0.378	6.186	
BMI (kg/m^2)				
Normal	2.68±0.612	1.52±0.508	9.488	

Overweight	2.71±0.726	1.42±0.515	5.475	0.001
Obese	4.00±0.001	1.50±0.707	4.567	
Mean duration of analgesia (minutes)	**145.73±13.23**	**190.82±33.71**	**0.001**	

S.D = Standard Deviation, % = Percentage, BMI = Basal Metabolic Index, p-value = <0.05 is significant

In this study, the Lidocaine plus Dexmedetomidine group showed significantly lower pain scores (1.49 ± 0.506) compared to the Lidocaine alone group (2.78 ± 0.704) with a p-value of 0.001. The analgesia duration was also longer in the combination group (190.82 ± 33.71 minutes) compared to Lidocaine alone (145.73 ± 13.23 minutes), with a p-value of 0.001, indicating better pain control and prolonged effect with Dexmedetomidine addition. The data suggest that combining Dexmedetomidine with Lidocaine improves pain management and extends analgesic duration with statistically significant evidence ($p < 0.05$), despite higher variability in the combination group's response. **Table 3** indicates the classification of the mean pain score (VAS) of different parameters between groups.

Table 4: Stratification of Mean Duration of Analgesia (minutes) Between Groups Concerning Different Variables

Variables	Groups		Test value	p-value
	Lidocaine alone Mean ± SD	Lidocaine plus Dexmedetomidine Mean ± SD		
Gender				
Male	145.62±13.020	186.42±35.321	5.983	
Female	145.89±13.876	195.86±31.875	6.238	0.001
Age groups				
18-30 years	144.29±15.020	192.27±35.121	4.630	
31-45 years	148.16±9.728	187.52±32.606	6.259	0.001
46-60 years	139.00±20.258	198.57±37.973	5.383	
BMI (kg/m^2)				
Normal	143.50±12.261	194.94±34.743	7.233	
Overweight	147.86±15.236	178.25±27.459	3.084	0.001
Obese	156.67±5.774	202.50±53.033	2.683	

S.D = Standard Deviation, % = Percentage, BMI = Basal Metabolic Index, p-value = <0.05 is significant

The lidocaine plus dexmedetomidine group had significantly lower mean pain score across all groups (p-value 0.001). Average improvement of 2.69±0.679-1.42±0.504 and 2.89±0.737-1.57±0.507 was observed in overall males and females, respectively. In the same way, the highest baseline pain, 3.50±0.548, was recorded in the oldest age group (46-60 years), using lidocaine alone, which was brought down to 1.86±0.378 under dexmedetomidine. Obese patients also demonstrated a significant reduction in pain between 4.00±0.001 and 1.50±0.707. It implies that dexmedetomidine can systematically decrease pain, particularly in patients at risk of increasing pain scores. **Table 4** classifies the mean duration of analgesia (minutes) between groups concerning different variables

With dexmedetomidine, there was a significant increase in the mean duration of analgesia in all subgroups ($p = 0.001$). Mean duration in males increased by 145.62 ± 13.02 to 186.42 ± 35.32 minutes, whereas in females,145.89 ± 13.88 to 195.86 ± 31.88 minutes of increased duration was observed. In older patients (46-60 years), the mean duration increased from 139.00 ± 20.26 to 198.57 ± 37.97 minutes. The obese patients experienced the longest duration: 156.67±5.77 compared to 202.50 ± 53.03 minutes. This suggests that the analgesia effect is adequately prolonged by such combinations, with the advantage in older and obese individuals who might otherwise possess a reduced baseline providing analgesia.

DISCUSSION

This study aimed to evaluate whether the addition of dexmedetomidine to lidocaine as an intravenous regional anesthesia (IVRA) can induce better postoperative pain management and decreased pain scores than lidocaine alone in patients undergoing below-elbow surgery. The findings validate that adding dexmedetomidine improves analgesia duration and reduces postoperative pain levels without escalating complications.

The findings indicated that the mean pain scores of patients on lidocaine with dexmedetomidine were uniformly lower in all genders, ages, and body mass index categories. This observation is consistent with research studies that recently reported the analgesic effects of dexmedetomidine as an adjuvant to regional blocks [10]. To illustrate, a study reported that VAS scores decreased significantly with the administration of dexmedetomidine and significantly enhanced the duration of the sensory block in brachial plexus blocks [11]. Similarly, its pain-sparing effect in excluding opioids in addition to peripheral nerve blocks has been demonstrated, whereas another study showed decreased tourniquet ache with IVRA [12,13].

These observations are supported by a study that demonstrated the improved quality of the block and prolonged analgesia with dexmedetomidine rather than clonidine [14]. This is explained by its increased ratio of 2:1 selectivity, increasing peripheral analgesia [15,16]. In patients undergoing upper limb procedures, dexmedetomidine combined with lidocaine was also found to significantly reduce pain and delay the first demand for analgesia [17].

Results obtained also align with the findings that showed dexmedetomidine prolonged sensory and motor block presentation with no major sedative or hemodynamic destabilization [18]. By reviewing and comparing several trials, it has been stated that dexmedetomidine prevented block duration more effectively than clonidine and magnesium sulfate[19,20]. Similarly, a study emphasized its usefulness in IVRA, stating better intraoperative comfort and less opioid requirement [21].

However, despite the current findings being consistent with these works, other studies show different findings. To illustrate, a study identified that the administration of dexmedetomidine provided inconsistent pain-reduction effects during tourniquets, whereas another study concluded that intravenously injected low doses of dexmedetomidine did not cause significant impacts on intraoperative discomfort [22,23]. Such differences might be explained by differences in dosing, administration route, or surgical procedures. The clinical implications of these results apply to other anesthesiologists interested in maximizing perioperative pain relief. The addition of dexmedetomidine to lidocaine during IVRA would offer more comfort to the patients, extend

postoperative analgesia, and decrease opioid demands [24]. This confirms the new guidelines supporting the idea of multimodal analogy and regional anesthesia optimization [25].

The present study has limitations of a single-center study with a relatively small sample size, which can restrict its generalizability. The details of hemodynamic parameters, sedation, and patient satisfaction were not examined. Moreover, this study lacked the evaluation of further neurologic side effects of dexmedetomidine application in IVRA. Subsequent studies need to consider larger multicentre trials to validate these findings, to fix the dosing, and compare dexmedetomidine with other adjuvants like dexamethasone or magnesium. To reinforce clinical recommendations, longitudinal studies with measurements of long-term effects on chronic pain and functional recovery are recommended.

CONCLUSION

This research showed that the addition of dexmedetomidine to lidocaine using intravenous regional anesthesia can significantly decrease the postoperative pain level and increase the duration of its effect in cross-limb procedures. The results revealed that the effect of dexmedetomidine, as an adjuvant, was robust and reliable in improving the overall outcome among gender, age, and BMI groups. These findings justify the initial goal to compare lidocaine alone and with dexmedetomidine to administer perioperative pain control.

Dexmedetomidine may be used as an adjuvant to lidocaine, can effectively be used in IVRA to enhance patient comfort, may help decrease postoperative opioid consumption, and is associated with multimodal pain management approaches. Its regular advantage in patients' subgroups has demonstrated its potential to be standardized in clinical practice as a short-term surgery of the upper limbs. Further investigations involving dosing optimization and long-term outcomes should support its use in regional anesthesia procedures.

LIST OF ABBREVIATIONS

IVRA	Intravenous Regional Anesthesia
VAS	Visual Analog Scale
ASA	American Society of Anesthesiologists
BMI	Body Mass Index
SPSS	Statistical Package for the Social Sciences

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

The study received ethical approval from Fatima Memorial Hospital, Lahore. This randomized control study was conducted in the Department of Anesthesiology from September 3, 2024, to March 2, 2025 (ref FMH-IRB-1566).

AUTHORS' CONTRIBUTION

All Authors Claimed to be in equal contribution as per ICMJE.

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