Observational Study of Lignocaine Alone and Lignocaine with Dexmedetomidine for Intravenous Regional Anaesthesia

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ABSTRACT

BACKGROUND

Dexmedetomidine is a selective α2 adrenoreceptor agonist, is more potent, and is highly lipid soluble which causes rapid systemic absorption and local anaesthetic effect. It is therefore a suitable choice for intravenous regional analgesia. Studies on peripheral nerves in-vivo have proved that dexmedetomidine may be safely administered for intravenous regional analgesia in combination with local anaesthetics. The present study compared the onset, quality, total duration, and efficacy of analgesia between the two groups and also attempted to study the toxicity between the two groups after the tourniquet is released.

METHODS

This is an observational study. Institutional Ethics Committee approval and written informed consent were obtained. Fifty patients in the age group 20-60 years belonging to ASA physical status 1 were selected to participate in the study. Both emergency as well as elective patients were included.

RESULTS

Minimum period of post-operative analgesia in the dexmedetomidine group (study group) was 180 mins. and maximum was 540 mins. with a mean value of 343.2 mins., in the control group it was varied from 5 mins. to 30 mins. with a mean of 17.8 mins.

CONCLUSIONS

Addition of 0.5 µg/Kg of dexmedetomidine along with 0.5% preservative free lignocaine can be recommended for intravenous regional analgesia of extremity surgeries as it offers a simple, inexpensive and safe means of good quality postoperative analgesia.

KEYWORDS

Dexmedetomidine, Preservative Free Lignocaine, Intravenous Regional Anaesthesia

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BACKGROUND

Dexmedetomidine is a selective α2 adrenoreceptor agonists and is more potent. Its high lipid solubility leads to rapid systemic absorption and local anaesthetic effect. It is a suitable choice for intravenous regional analgesia. Studies on peripheral nerves in vivo have proved that dexmedetomidine may be safely administered for intravenous regional analgesia in combination with local anaesthetics. The present study compared the onset, quality, total duration and efficacy of analgesia between the two groups and also attempted to study the toxicity between the two groups after the tourniquet is released.

METHODS

Fifty patients in the age group of 20-60 years belonging to ASA physical status I were selected to participate in the study. All patients were scheduled for upper limb operations of orthopaedic and plastic procedures. Both emergency as well as elective patients was included.

Exclusion Criteria

- Coexisting systemic illness.
- Patients with known history of hypersensitivity to local anaesthetic drugs.
- Patients with peripheral vascular disease.
- Surgeries lasting more than 90 minutes.
- Sickle cell disease.
- Infection to limb.

Methodology

A thorough pre-operative assessment was done on the day of surgery to exclude any systemic illness like epilepsy, hypertension, ischaemic heart disease, diabetes mellitus and vascular and haematologic diseases. Body weight was recorded, and an informed consent was taken. Fifty patients were randomly allocated into two groups of twenty-five each.

Group I: (Study Group)

Received intravenous regional anaesthesia[1] (Bier's Block) with 40 ml of preservative free lignocaine 0.5% and 0.5 µg/Kg of dexmedetomidine.

Group II: (Control group)

Received intravenous regional anaesthesia (Bier's Block), with 40 ml of preservative free lignocaine 0.5% alone. Patients were not aware as to which group they belonged to.

Pre-Operative Preparation

All patients were kept nil per oral for 8 hours prior to surgery. No sedative premedication was administered to the patient prior to surgery.

Anaesthetic Technique

The procedure was explained to the patient to minimize anxiety and to get the patients co-operation for proper assessment. Injecting 0.1 ml of the solution subcutaneously tested sensitivity to local anaesthetic. The pulse rate and blood pressure were checked. Before taking the patient to the theatre all resuscitation equipment and drugs were kept ready. The dose of the drug was calculated according to the body weight of the patient.

The patient was shifted to the theatre, kept on supine position. Blood pressure was checked with non-invasive BP cuff and three ECG leads were attached for continuous monitoring of the heart rate. Pulse oximeter probe was also attached to the normal upper limb. An intravenous line was started on the normal limb with and 18G cannula with lactated ringer's solution. A venipuncture was done on the dorsum of the hand to be operated upon with a 22G or (20G) cannula and secured. Two sphygmomanometer[2] cuffs were firmly applied to the upper arm one below the other over the paddings. The occlusion pressure was then measured with the tourniquet, (the cuff pressure required to completely obliterate the radial pulse) on the arm to be operated upon. The limb was then raised for 3-5 minutes for exsanguination in order to reduce the blood volume. The proximal cuff was then inflated to a pressure 100 mms of Hg above the occlusion pressure and inflation pressure was maintained by putting clamps over the tubing. The arm distal to the cuff was then inspected to test the competence of the tourniquet, If competent the arm appears ischaemic and pulseless with pale or mottled appearance and with no evidence of venous congestion. The calculated dose of drug was then injected over a period of 90 seconds. The patients in the study group received 40 ml of 0.5% preservative free lignocaine (Xylocard) with 0.5 µg / kg of dexmedetomidine. The patients in the control group received 40 ml of preservative free (Xylocard) alone.

After injection of the drug the cannula was removed. The time of injection was noted. The onset of analgesia was noted as loss of pinprick in every 15 seconds. The time of onset of muscle relaxation was noted in every minute. The muscle power was tested as follows- Grade V– Normal, Grade IV- Ability to move against resistance, Grade III- Ability to overcome gravity only, Grade II- Ability to move but not against resistance, Grade I- Trace or palpable contraction, Grade 0- No contraction. After ensuring adequate analgesia and muscle relaxation, the surgeon was allowed to proceed with surgery. No intra operative sedation was administered. Intra operative fluid maintenance was done with lactated ringer's solution. The second tourniquet was inflated once analgesia was established or when the patient complained of discomfort due to tourniquet.

Grading of Quality of Analgesia

Excellent: Indicated by complete loss of touch, position, sense, no sensitivity to pin prick or deep pressure marked or fatal paralysis of muscle. Good: Loss of all sensation as

in (1) but sensory response to deep pressure applied to fingertips, motor paralysis less than total, but usually presented late during operation. Moderate or Fair: Analgesia was complete in most of the areas but adequate in some. Mild pain or discomfort during reduction or operative procedure but GA not required. Poor or Failure: Failure to obtain anaesthesia or marked pain during surgical procedure, requiring GA.

Intra operatively pulse rate, BP, rates of respiration, signs of systemic toxicity were observed at regular interval of 10 minutes, Conversation with the patient was maintained throughout to know the level of consciousness and any complaints. The tourniquet pressure was constantly monitored. Total duration of surgery and tourniquet time noted. At the end of surgery, the tourniquet was released with intermittent deflation (for 5 second) and re-inflation (for 45 second) repeated 4-5 times before finally removing it. Patients were closely observed for any untoward effect of systemic toxicity of local anaesthetic and for respiratory depression, following parameters recorded- 1. Onset of analgesia and muscle relaxation. 2. Quality of analgesia. 3. Total duration of surgery. 4. Total duration of tourniquet inflation. 5. Duration of post tourniquet release analgesia or total duration of analgesia.

Complications

Post-operatively patients were closely monitored for about 30 minutes for any abnormal pulse, BP and untoward symptoms like respiratory depression, drowsiness, giddiness, tinnitus, tingling of in the fingers or tongue, any muscle twitching or convulsions. Postoperative analgesia was tested in every 15 minutes for 1 hour and thereafter every 2 hours for 24 hours. The duration of postoperative analgesia was calculated as the time interval between the deflations of tourniquet to the appearance of discomfort due to pain (score 2). The exact time of appearance of discomfort due to pain was noted, Systemic analgesics were administered (Ketorolac 30 mg)[3] intra muscularly as the patient complained of discomfort due to pain. Injection pethidine 1 mg /Kg was administered intramuscularly only in those situations where patients had severe persisting pain, which was not relieved with NSAIDs. The efficacy of post-operative analgesia was evaluated using Magill's scoring system.

Score Quality of Analgesia

- No pain
- Slight pain
- Discomfort due to pain
- Unbearable pain
- Excruciating pain

The total number of doses of analgesic required was also noted. Post-operative incidence of side effects was closely watched for. Patients who developed bradycardia and hypotension immediately after release of tourniquet were treated with injection Atropine 0.6 mg intravenously and small dose of vasopressor like mephentermine 6 mg IV along with rapid infusion of intravenous fluid. Those patients who appeared drowsy following the release of tourniquet, patient was checked that whether they were arousable on verbal command. Patients who had generalized pruritis were treated with intramuscular injection of pheniramine maleate. The arithmetic mean and standard deviation of the various parameters were calculated. The comparison between the two groups were accomplished using the students two sample 't' test whenever applicable, p <0.05 was considered to be significant. The mean value in either group were compared using the student's ^{x}t' using the formula:

$$t = \frac{|\bar{X}_1 - \bar{X}_2|}{SE}$$

SE is the standard error; it was calculated as follows.
S - pooled standard deviation of both groups
n_1 = Frequency of 1st sample
n2 = Frequency of 2nd sample

$$SE = S \sqrt{\frac{1}{n_1} - \frac{1}{n_2}}$$

Pooled standard deviation 'S' was obtained as follows

$$S = \sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2}}$$

S1 = Standard deviation of study group.
S2 = Standard deviation of control group.
P<0.05 was considered statistically significant.

RESULTS

Fifty patients took part in this study. Twenty-five patients received IVRA with 40 ml of 0.5% preservative free Lignocaine (2% Xylocard 10 ml + 30 ml of NS) with 0.5 µg/Kg of dexmedetomidine. They were designated as the study group. Twenty-five patients belonging to the control group received 40 ml of 0.5% preservative free lignocaine alone for IVRA. (2% Xylocard 10 ml+ 30 ml of normal saline). The results were analysed as follows.

Age Group (in ears)	Group I (Study) Dexmedetomidine		Group II (Control) Lignocaine	
	No.	%	No.	%
20-29	11	44	10	40
30-39	5	20	5	20
40-49	3	12	4	16
50-60	6	24	6	24
Mean age	35.88		35.76	

Table 1. Age Distribution of Patients

The age of patients ranged from 20-60 years. Mean age in study group was 35.88 Mean age in control group was 35.76. The maximum number of patients in either group was in the 20-29 years age group.

Weight in Kgs.	(Study Group) Dexmedetomidine		(Control) Lignocaine	Group
	No.	%	No.	%
45 ~ 49	5	20	3	12
50-59	14	56	14	56
60 " 69	6	24	8	32
Mean Weight	54.92		55.76	

Table 2

The mean body weight in the study group was 54.92 kg. The mean body weight in the control group was 55.76 kg. The maximum number of patients in either groups belonged to the 50-59 kg group. The maximum number of patients in both the control and the study group were those for orthopaedic surgeries of the upper limb.

Type of Surgery	(Study Group) No.	%	(Control Group) No.	%
Orthopaedic Surgery	22	88	20	80
Plastic Surgery	3	12	5	20

Table 3

Onset of Analgesia (in seconds)	(Study Group) No.	%	(Control Group) No.	%
0-60	6	24	0	0
61 - 120	19	76	0	0
121-180	0	0	13	52
181 - 240	0	0	7	28
> 240	0	0	5	20
Mean Onset	91.1 Sec		219.8 Sec	

Table 4

't' = 2,73 p < 0.05

In the study group all the patients had an onset of analgesia within 120 seconds and in 6 patients it was within 60 seconds. In the control group 13 out of 25 had an onset of analgesia within 180 seconds and in 7 it was within 240 seconds and 5 patients it was delayed (300 ~ 360 second). Applying the student Y test this difference was statistically significant p <0.05.

Onset of Muscle Relaxation (Minutes)	(Study Group) No.	%	(Control Group) No.	%
5-10	3	12	0	0
11-15'	22	88	21	84
>15	0	0	4	16
Mean Onset	11.32 mins.		14.27 mins.	

Table 5

In the study group all patients had an onset of muscle relaxation within 15 minutes with a mean of about 11.32 minutes. In the control group 21 patients had an onset of muscle relaxation within 15 minutes but 4 patients had a delayed onset above 15 minutes (16 minutes) with a mean of 14.27 minutes. Applying student's' test this difference was highly significant statistically p value <0.001. Assessment of quality of analgesia and muscle relaxation. The quality of analgesia and muscle relaxation was assessed according to the criteria discussed earlier. In the study group the quality of analgesia was excellent in 22 out of 25 patients and 3 patients had good analgesia. In the control group 15 patients had excellent analgesia and 10 had good analgesia. The degree of muscle relaxation was almost equal on both groups. All patients had grade II muscle power.

Quality of Analgesia	(Study Group) No.	%	(Control Group) No.	%
Excellent	22	88	15	60
Good	3	12	10	40
Fair	0	0	0	0
Poor	0	0	0	0

Table 6

Tourniquet Pain

Seventeen patients, in the control group experienced mild discomfort at the tourniquet site 45 minutes after inflating the cuff and nine out of 25 patients in the study group developed discomfort due to tourniquet after 50 minutes of cuff inflation. But they did not require any analgesia. The average tourniquet time in study group was 56.2 minutes and in control group it was 51.2. The average duration of surgery in study group was 55.4 minutes and in control group it was 50.4 minutes.

Variable	(Study Group)	(Control Group)
Mean tourniquet time (in minutes)	56.2	51.2
Mean Surgery time (in minutes)	55.4	50.4

Table 7

Duration of Post-operative Analgesia (Minutes)	(Study Group) No.	%	(Control Group) No.	%
0-60	0	0	25	100
61 -120	0	0	0	0
121 - 180	4	16	0	0
181 - 240	4	16	0	0
241 - 300	3	12		0
301 - 360	5	20	0	0
361 - 420	4	16	0	0
421 - 480	3	12	0	0
481 -12 hours	2	8	0	0
13 - 24 hours	0	0	0	0
Mean duration	343.2 minutes		17.8 minutes	

Table 8

't' 20 p< 0.001

The minimum period of post-operative analgesia in the study group was 180 minutes and maximum was 540 minutes with a mean value of 343.2 minutes, in the control group it was varied from 5 minutes to 30 minutes with a mean of 17.8 minutes. Applying student 't' test the difference in the duration of analgesia was statistically highly significant.

Maximum Pain Score Obtained in 24 Hrs Postoperative Period	(Study Group) No.	%	(Control Group) No.	%
0	0	0	0	0
1	1	4	0	0
2	20	80 1	4	16
3	4	16	15	60
4	0	0	6	24

Table 9

Y - 6,225 p <0.01.

In the 24-hour post-operative period, in the study group 20 patients had a maximum pain score of 2 whereas only 4 patients on the control group had similar score over the same period. Applying the test for significance, the difference in the intensity of analgesia in the study group as compared to that of the control group was found to be statistically significant, p value <0.01.

Side Effects	(Study Group)		(Control Group)	
	No.	%	No.	%
Bradycardia	2	8	2	8
Hypotension	2	8	1	
Drowsiness	16	64	0	0
Respiratory Depression	0	0	0	0
Pruritis	1		0	0

Table 10

Efficacy of Analgesia

After 3 hours in the post-operative period 21 patients in the study group had a score of zero whereas none in the control group had a similar score. 2 patients in the study group developed a reduction in pulse rate and blood pressure in the immediate post tourniquet release period. 16 patients in study group developed drowsiness and one had pruritis. In the control group 2 patients had bradycardia and one developed hypotension and others had no major side effects. None in the study group and control group had respiratory depression or central nervous system toxicity.

DISCUSSION

Clinical observations have clearly indicated that α2 adrenoreceptor agonists and local anaesthetics for intravenous regional analgesia have synergistic effect. Addition of dexmedetomidine and fentanyl hastens onset of analgesia, muscle relaxation and prolongs the total duration of analgesia and also the efficacy of analgesia. Dexmedetomidine is selective α2 adrenoreceptor agonists and is more potent. Its high lipid solubility leads to rapid systemic absorption and local anaesthetic property, it is a suitable choice for intravenous regional analgesia. Studies on peripheral nerves in vivo have proved that dexmedetomidine may be safely administered for intravenous regional analgesia in combination with local anaesthetics/[4]

The present study[4] compared the onset, quality, total duration and efficacy of analgesia between the two groups and also attempted to study the toxicity between the two groups after the tourniquet is released. The onset of analgesia in the study group was determined to be 91.1 seconds (mean) ranging from a minimum of 60 seconds to a maximum of 120 seconds. In the control group it was 219.8 seconds (mean) ranging from a minimum of 180 seconds to a maximum of 360 seconds. This result was statistically significant with a p value of < 0.05.

The results of this is study[5] is comparable with the study of Ghosh and colleagues in 60 patients of two groups. The mean onset of analgesia in the dexmedetomidine groups was 83 seconds ranging from 60-120 seconds. In the control group it was 156 seconds ranging from 60-240 seconds. The onset of muscle relaxation was also compared between the two groups in the present study. The results showed that the study group has a mean onset of muscle relaxation of 11.32 minutes with a minimum of 9 minutes and a maximum of 12 minutes. In the control group the mean onset of muscle relaxation was 14.72 minutes with a minimum of 13 minutes and to a maximum of 16 minutes. The difference in the onset of muscle relaxation was significant statistically with a p value of <0.01. The muscle relaxation was rapid and profound in study group. All patients on both study group and control group attained a grade II power.

This is also comparable with the study of Ghosh and colleagues. They compared the effect of addition of dexmedetomidine to lignocaine in 30 patients. The mean onset of muscle relaxation in dexmedetomidine group was 9.3 ± 2.02 minutes. Dexmedetomidine hastened the onset of intravenous regional analgesia may be because of its local anaesthetic property.[6] The quality of analgesia[6] was also compared between the two groups. 22 out of 25 patients in the study group attained excellent quality of analgesia and three had good analgesia. In control group 15 patients had excellent analgesia whereas 10 had good analgesia.

The total duration of surgery and tourniquet time were studied. They showed no significant difference between the two groups. The mean duration of surgery in study group was 55.4 minutes and in control group it was 50.4 minutes. The mean tourniquet time in study group was 56.2 minutes and in control group it was 51.2 minutes. Seventeen patients in control group experienced mild discomfort at tourniquet site after 45 minutes whereas only nine patients had tourniquet discomfort after 50 minutes in study groups. But they did not require any analgesia. The total duration of post tourniquet release analgesia was compared between the 2 groups. The total duration of analgesia was 343.2 minutes ranging from 180 minutes to 540 minutes. In the control group it was 17.8 minutes with a range of 5 minutes to 30 minutes. This difference was statistically highly significant with a p value of <0.001.

The results of this study is comparable with that of Ghosh and colleagues, but the duration of analgesia is more in the present study. The mean duration of analgesia in Ghosh's study was only 134 minutes (mean), whereas in the present study it is 343.2 minutes. Those patients who complained of pain in the postoperative period were treated with Ketorolac Tromethamine 30 mg intramuscularly. Those patients who complained of unbearable and excruciating pain have given injection pethidine 1 mg/Kg intramuscularly as their pain was not relieved with weaker analgesics. In the study group none of the patient required opioids during the 24-hour post-operative period.

Thus, it was observed that another advantage of addition of α2 agonists to intravenous regional analgesia is the lower requirement rate of parenteral opioids in the 24-hour postoperative period. The patients were evaluated for efficacy of postoperative analgesia using Magill's scoring system. After three hours following surgery 21 patients in the study group had a score of Zero (no pain). Whereas none in the control group had a zero score at 3rd postoperative hour. On analysing the postoperative pain score, the study group had better quality of pain relief compared to the control group. The difference in the intensity of analgesia in the study group was statistically significant during the 24 hours postoperative period ($p < 0.01$) as compared to control group.

The results of this study are comparable with that of Lilienfield.[7] Their study proved that addition of dexmedetomidine to Lignocaine required no analgesia in the first 60 minutes following tourniquet release. In contrast to their study present study obtained no analgesia for the first 3 hours in 21 patients. No patient in the study group and control group developed central nervous system toxicity. This may be due to the longer tourniquet time in both study and control group. Pulse rate, systolic blood pressure and ECG were monitored throughout the surgery period and immediate postoperative period. No abnormality in the electrocardiogram noted in both the intraoperative and post tourniquet release period. Patients in the study group and control group developed bradycardia and hypotension in the immediate tourniquet release period. This effect may be due to the systemic effect of Lignocaine and dexmedetomidine. They responded to Inj. Atropine 0.6 mg and 6 mg of intravenous mephentermine.

Only one patient in the study group developed pruritis in the intra operative period and responded to Inj. Pheniramine maleate. None of the patient in the control group had pruritis. The low incidence of pruritis in our study could be explained probably due to the relatively small study sample. Addition of dexmedetomidine to Lignocaine showed beneficial effects due to the peripheral opioid receptor activity and also because of its local anaesthetic like property. The peripheral opioid receptors reduce the propagation of nociceptive action potentials and diminish the release of excitatory neuropeptides.[8] The lack of significant side effects can also be explained with peripheral opioid receptor activity.[9]

The present study of intravenous regional analgesia for upper limb surgeries was done in 50 patients belonging to age group between 20 and sixty years of ASA Grade I .patients. Group I patients received 40 ml of 0.5% preservative free lignocaine with 0.5 µg/Kg of dexmedetomidine and group II patients received 40 ml of 0.5% preservative free lignocaine alone for intravenous regional analgesia. The study compared the effect of addition of dexmedetomidine to lignocaine in onset of analgesia and muscle relaxation. Also assessed the quality, efficacy and total duration of analgesia along with incidence of side effects.

CONCLUSIONS

IVRA is a simple method of producing anaesthesia of limbs. It is a reliable technique and has rapid onset of action. Good analgesia and muscle relaxation are obtained along with blood less field for surgery. The technique can be useful in outpatient surgeries. The study proved that addition of dexmedetomidine to lignocaine reduced the time of onset of analgesia and muscle relaxation. There is significant prolongation of duration of analgesia in the post tourniquet release period. The quality and efficacy of analgesia was better in the study group than in the control group. No significant major side effects observed. The present study concludes that addition of 0.5 µg/Kg of dexmedetomidine[10,11] along with 0.5% preservative free lignocaine can be recommended for intravenous regional analgesia of extremity surgeries as it offers a simple, inexpensive and safe means of good quality postoperative analgesia.

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