

EFFECT OF DEXAMETHASONE FOR IMPROVING ANALGESIA QUALITY IN AXILLARY BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES : A COMPARATIVE STUDY

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ABSTRACT:

Background: Various adjuvants have been used to prolong the duration of local anaesthetic action after peripheral and regional block. We evaluated the effect of dexamethasone 8mg added to Fixed constant Mixture of Lignocaine and Bupivacaine on the duration and quality of pain relief in upper limb surgeries performed under axillary brachial plexus block using Dexamethasone .**Methods:** In this prospective randomized double-blind controlled study Total 50 patients [age 20-40 years] of ASA I and II undergoing elective upper Limb surgery under Axillary brachial Plexus Block were randomized into two groups. Patients in Group1(n=25) received 12 ml bupivacaine 0.5% + 8ml lignocaine2% + 12ml Normal Saline And We Injected 12ml bupivacaine0.5% + 8ml lignocaine 2 % + 10 ml Normal Saline + 2ml Dexamethasone in Group 2(n=25) . Total 32 ml. volume of drug administered in both groups. Onset and recovery time of sensory and motor block, duration of analgesia and quality of block, hemodynamic variables, oxygen saturation were studied in both the groups. **Results:** The mean onset of motor block for Group I was 11.80±2.000 (min) for Group 2 was 11.08± 2.080 (min) and the difference was found to be statistically not significant between Group I and Group 2 (p >0. 05). Mean onset of sensory block for Group I was 9.12±1.394 (min) for Group 2 was 8.68±1.887(min) and this difference was not statistically significant between both groups (p >0.05). The mean duration of motor block (180.68±8.459 (min)) was significantly lower in Group I as compared to Group 2 which was 203.20±25.936 min. (P value<0.001) The mean duration of analgesia in Group I was 222.52±9.713 (min) and it was significantly lower as compared to Group 2 which was 279.52±74.411 (min). (p value < 0.001) **Conclusion:** Addition of dexamethasone (2ml) to local anaesthetic mixture for axillary brachial plexus block prolongs the duration of anaesthesia and postoperative analgesia and decreases the rescue analgesic consumption and VAS score postoperatively without any potential side effects.

Keywords: axillary brachial plexus block, dexamethasone, Postoperative analgesia.

INTRODUCTION:

Fine Pain has been a major concern of human kind and it has been the object of ubiquitous efforts to understand and to control it. The term

“Regional anaesthesia” was first coined by Harvey Cushing in 1901 to illustrate pain relief by nerve block.^{1,2} Regional nerve blocks is

worked on the concept that pain is communicated by nerve fibers, which are agreeable to reversible interruption to conduction of impulses anywhere along their pathway.³ Brachial Plexus block provide anaesthesia of whole upper extremity in the most consistent and time efficient manner. It gives both intraoperative anaesthesia and postoperative analgesia without any systemic side effects. Peripheral nerve blocks are associated with sympathetic block, with resultant improvement in blood flow hence, lesser postoperative vasospasm, tissue anoxia, pain, edema which is favourable in hand and reconstructive surgery. Numerous techniques⁴ for blocking the brachial plexus at various levels have been described. These are: Interscalene - Winnie AP (1970), Parascalene - Dalens B (1987), Subclavain perivascular - Winnie & Collins (1964), Suprclavicular - Kulenkampff (1911), Infraclavicular - first described by L. Bazy and V. Pauchet in 1917 and later bring into vogue by P. Raj (1973), Axillary - Hirshchel (1911) Local anaesthetics have been the mainstay drugs for institution of brachial plexus block since the advent of this technique. However, due to lack of desirable features and concerns regarding toxicity, interest has developed in using other classes of drugs as adjuvant for overcoming the pharmacological short comings of these drugs Local anaesthetics alone provide analgesia for about 4-8 hours. Increasing the duration of local anesthetic action is often sought-after because it prolongs surgical anesthesia and analgesia. Vasoconstrictors constrict vessels, thus reducing vascular absorption of the local anesthetic. opioids, clonidine, verapamil etc were added to local anaesthetics as adjuvants to prolong regional blockade but the results are either inconclusive or associated with side effects.⁵⁻⁷ Steroids are being used in low concentration in peripheral nerve blocks. Steroids are very potent anti inflammatory as well as analgesic agents. Perineural steroids is documented to influence postoperative analgesia. They alleviate pain by reducing inflammation and blocking conduction of nociceptive C-fibres and by inhibiting ectopic neural discharge.⁸ Some

studies have shown the analgesic effect of local, spinal and systemic corticosteroids in combination with bupivacaine.^{9,10} Dexamethasone microspheres have been documented to increase the duration of block in animal and human studies and adding methyl prednisolone to local anesthetic prolongs the duration of axillary brachial plexus block.¹¹⁻¹⁴ In this study, We investigated the effect of adding dexamethasone 8mg to fixed constant mixture of Lignocaine and Bupivacaine in axillary brachial plexus block on the sensory and motor blockade and duration of analgesia.

METHODS:

The study was conducted in the Department of Anesthesiology, S.M.S Medical College, Jaipur. This randomized double-blind controlled study included 50 ASA Grade-I and II patients, age 20-40 years, Body weight 50 to 70 kg who underwent elective surgical procedure on upper limb of duration 1-4 hrs. Approval from the institutional ethical committee and review board and written informed patient consent was obtained. It was a Hospital based, Randomized, Double-Blind study.

Sample Size:

As per time taken for ready to surgery Size: Expecting difference of means to be detected in mean onset of block 1.75 ± 1.97 minutes in Group 1-12ml bupivacaine 0.5%+8ml Lignocaine 2%+12ml normal saline (total volume 32ml) and Group 2- 12ml bupivacaine 0.5%+8ml Lignocaine 2 %+10 ml normal saline+2ml dexamethasone (total volume 32ml) [as per seed article] the sample size calculated was 21 subjects for each group at alfa error 0.05 and power 80% sample size for other variable like mean onset of motor block and mean duration of analgesia was calculated less than 21 subjects for each group so for the study purpose 25 subjects for each group will be taken. Patients who had local pathology at the site of injection or disability limiting the performance of block, history of convulsion, allergy to the drug used, bleeding disorder, severe neurological deficit, patient with history of respiratory, cardiac, hepatic or renal disease,

diabetic and uncooperative patients were excluded from the study.

Pre Anesthetic Check up was done a day before the surgery. Complete history of the patient including any known drug allergy, general and systemic examination and local examination of supraclavicular area, pulse rate, blood pressure, respiratory rate and weight of the patient were noted. Routine relevant investigations were done in all the patients.

Written Informed consent was obtained for performance of block after complete explanation about the study protocol and the procedure. Visual analogue scale (VAS) 0-10 was explained to the patients.

The patients were randomized on the day of surgery into one of the two predefined groups by chit and box method. Patient pull out the chit by him/herself. Medications were prepared by one anaesthesiologist and observations were made by another anaesthesiologist who was blinded to the drug administered. Fasting status, consent, preanaesthetic checkup checked and intravenous access secured. The patient was placed in the supine position, with the head turned away and the ipsilateral arm abducted at 90 degrees at the elbow. The axillary area was sterilized with aqueous iodine solution. We identified the axillary artery by palpation and inserting a 22gauge hypodermic needle above and parallel to the artery, advancing it while aspirating. Blood was aspirated and redirected the needle until a paresthesia was noted. When paresthesia occurred then we injected **12 ml bupivacaine 0.5% + 8ml lignocaine 2% + 12 ml Normal Saline** in Group 1 And We Injected **12 ml bupivacaine 0.5% + 8 ml lignocaine 2 % + 10 ml Normal Saline + 2 ml Dexamethasone** in Group 2 .

Onset of sensory block was evaluated by pinprick at 1 minute interval till a score of 1. Onset of motor block was assessed by modified Bromage scale every minute after the block till a score of 3 is achieved. Intraoperatively vital parameters pulse, B.P, SPO₂, R.R recorded every 5 minutes for first 30 minutes thereafter every 15minutes till completion of surgery In the

postoperative period pain assessed by visual analog scale, motor power by modified Bromage scale and vitals at 0 minute,30minutes,1,3,6,12 and 24hrs after completion of surgery

Scales Used For Scoring:-

Sensory Block 0 – Sharp pain 1 - Touch sensation only 2 - Not even touch sensation

Motor Block(modified Bromage scale)²⁴= 4- Full strength in relevant muscle groups, 3- Strength reduction, but able to move against resistance, 2- Ability to move against gravity, but not against resistance, 1- Discrete movements (trembling) of muscle groups, 0- Absence of movements

Visual analogue scale = Score 0 : No pain, Score 1, 2, 3 : Mild pain, Score 4, 5, 6 : Moderate pain , Score 7, 8, 9 : Severe pain, Score 10 : Worst Imaginable pain.

Definitions:

- Onset of sensory block was defined as time from injection till disappearance of sharp pain by pin prick test on skin dermatome C4–T2
- Onset of motor block was defined as time from injection till motor paralysis equivalent to Bromage score 0.
- Duration of analgesia (sensory block) was defined as the time between onset of sensory block and first dose of rescue analgesic (VAS > 4).
- Duration of motor block was defined as the time between onset of motor block to complete return of motor power (Bromage 4).
- Pain was assessed using visual analog scale where zero (0) represents nopain, and 10 means the worst possible pain.

Hypotension was defined as 25% decrease in mean arterial pressure (MAP) from baseline. Bradycardia was defined as Heart rate below 60 beats/minute. Tachycardia was defined as Heart rate more than 120 beats/minute. Sensory and motor blocks was assessed at 0 minute, 30minutes, 1hour, 3hours, 6hours, 12hours and 24hours after in the post Operative.

Analysis of data –

Data were analyzed using unpaired student “t” test for data on ratio and interval scale whereas data on ordinal and nominal scales were compared using Mann Whitney’s U test and Chi Square test respectively.

A “p” value of less than 0.05 was considered significant. End point of study –complete recovery of motor and sensory block

RESULTS

Demographic Observations

All confounders age, sex, weight and duration of surgery were comparable in both the group indicating absence of these biases.

Study Observations

Distribution of the cases according to mean Onset of Motor Block

The mean onset of motor block for Group I was 11.80±2.000 (min) , for Group 2 was 11.08±2.080 (min) and the difference was found to be statistically not significant (p >0. 05).

Distribution of the cases according to mean onset of sensory block

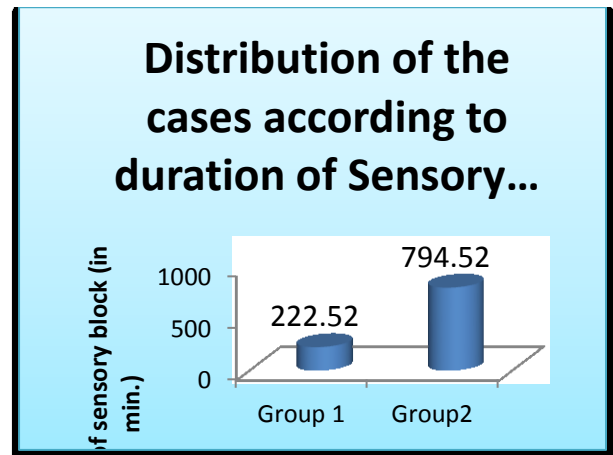
Mean onset of sensory block for Group I was 9.12±1.394 (min) ;for Group 2 was 8.68±1.887 (min) and this difference was not statistically significant between both groups (p >0.05).

Distribution of the cases according to duration of motor block (in minutes)

The mean duration of motor block (180.68±8.459 (min)) was significantly lower in Group I as compared to Group 2 which was 203.20±25.936 min. (P value<0.001)

Distribution of the cases according to duration of analgesia (Sensory Block) in Minutes

The mean duration of analgesia in Group I was 222.52±9.713 (min) and it was significantly lower as compared to Group 2 which was 794.52±74.411 (min). (P value < 0.001)



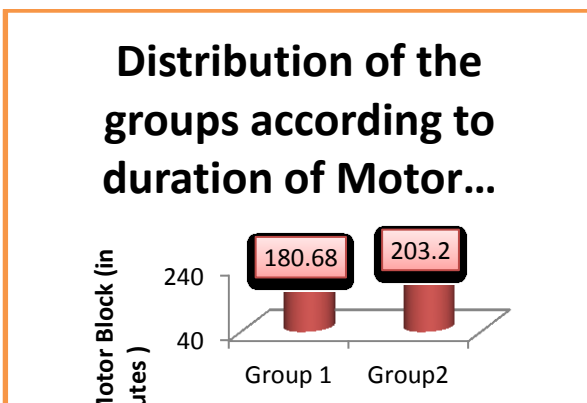
Distribution of the cases according to Grade of Motor Block

In group I grade 2 block was achieved in 11 out of 25 patients, in group 2 grade 2 block was achieved in 16 out of 25 patients and In group I grade 3 block was achieved in 14 out of 25 patients, in group 2 grade 3 block was achieved in 9 out of 25 patients. But no significant difference was observed according to grade of motor block.

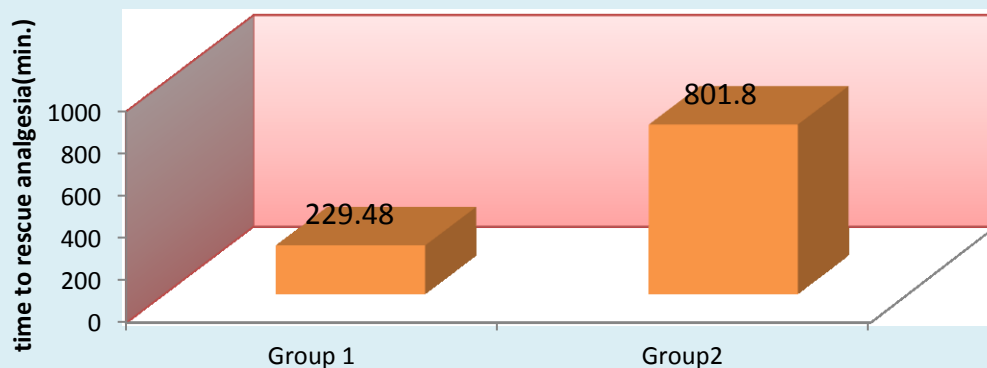
Distribution of the cases according to time of rescue analgesia (in minutes)

time to rescue analgesia (vas>4)	Group 1	Group 2	P Value LS
	229.48 ±8.09	801.8± 71.83	<0.001 S

Significantly higher mean time of rescue analgesia was observed in group 2 as compared to group 1 (801.80±71.83 vs 229.48±8.09 min.).



Distribution of the cases according to time to rescue analgesia



Distribution of the cases according to Baseline Clinical Variables

The baseline parameters HR, SBP, DBP, SpO₂, RR were comparable in both groups and no statistical difference was observed. ($p > 0.05$)

Distribution of patients according to Grade of Sensory Block

In group I grade 2 block was achieved in 10 out of 25 patients, in group 2 grade 2 block was achieved in 17 out of 25 patients. In group I grade 1 block was achieved in 15 out of 25 patients, in group 2 grade 1 block was achieved in 8 out of 25 patients and no significant difference was observed according to grade of sensory block ($p > 0.05$).

The parameters HR, Mean SBP, Mean DBP, SpO₂, RR found not significant difference between group I and group 2 at baseline, 5,10,15,20,25,30,45,60,75,90 and 105 minutes. postoperative mean systolic BP, Mean DBP, SpO₂, RR with standard deviation at various time points after surgery in both groups upto 24 hrs noted and found not significant difference between group I and group 2 at 0min, 30min,1hr,3hr,6hr,12hr,18hr,24hr.

Table 19 shows postoperative mean Visual Analogue Score with standard deviation at various time points after surgery in both groups upto 24 hrs and found significant

difference between group I and group 2 at 1hr,3hr,6hr,12hr,18hr,24hr and not significant difference between group I and group 2 at 18hr,24hr.

Both groups had 0 pain score in the post operative period at 0, 30 min. [vas=0]

At 1 hr. Group I recorded 4 patients with mild pain (VAS 1-3), 21 patients with no pain (VAS =0) . Group 2 recorded all patients with no pain [vas=0].

At 3 hrs. Group I recorded all patients with moderate pain (VAS 4-6), Group 2 recorded all patients with no pain [vas=0].

At 6 hrs. Group I recorded all patients with moderate pain (VAS 4-6), Group 2 recorded 11 patients with no pain[vas=0], 14 patients with mild pain[vas1-3].

At 12 hrs. Group I recorded 4 patients with mild pain[vas1-3], 21 patients with moderate pain (VAS 4-6), Group 2 recorded recorded 15 patients with mild pain[vas1-3], 10 patients with moderate. p

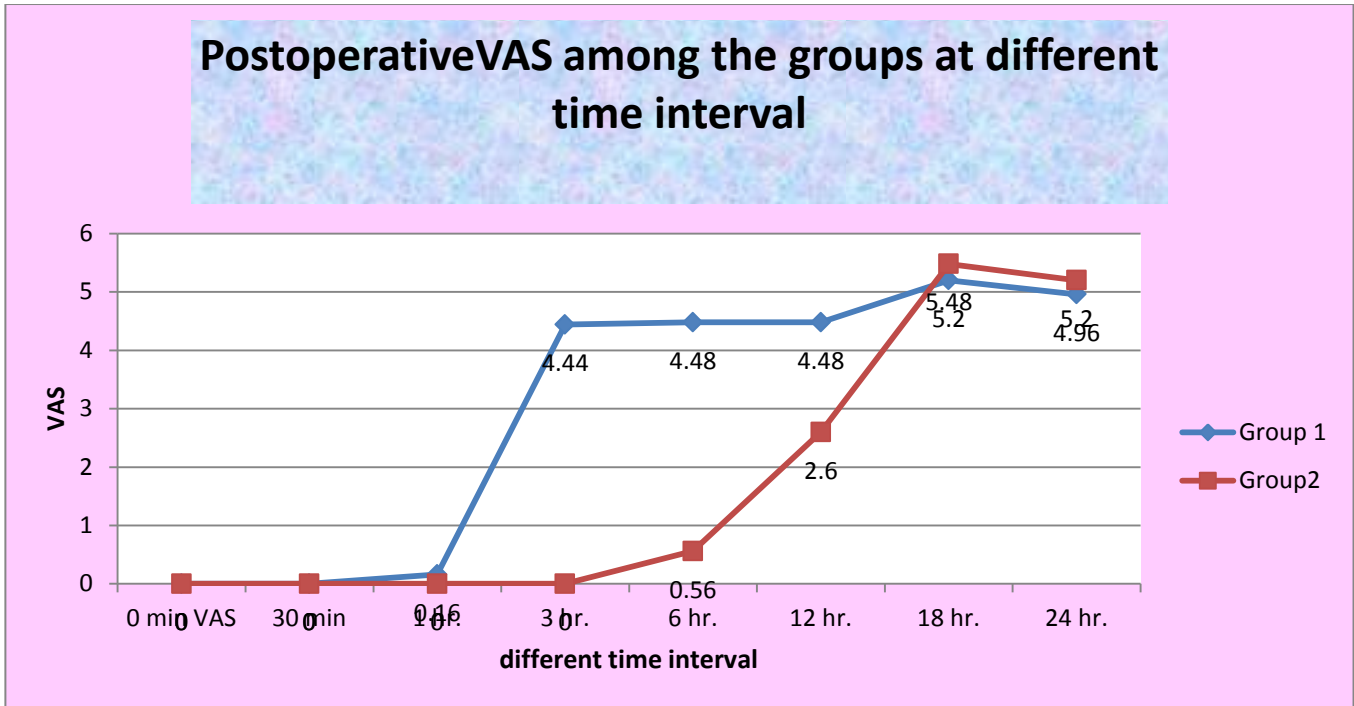
At 18 hrs. Group I recorded 3 patients with mild pain [vas=1-3], 15 patients with moderate pain [vas4-6] and 7 patient with severe pain [vas7-9]. Group 2 recorded 4 patients with mild pain [vas=1-3], 13 patients with moderate pain [vas4-6] and 8 patient with severe pain [vas7-9].

At 24 hrs. Group I recorded 2 patients with mild pain [vas=1-3], 23 patients with moderate pain

[vas4-6] . Group 2 recorded 2 patients with mild pain [vas=1-3], 20 patients with moderate pain

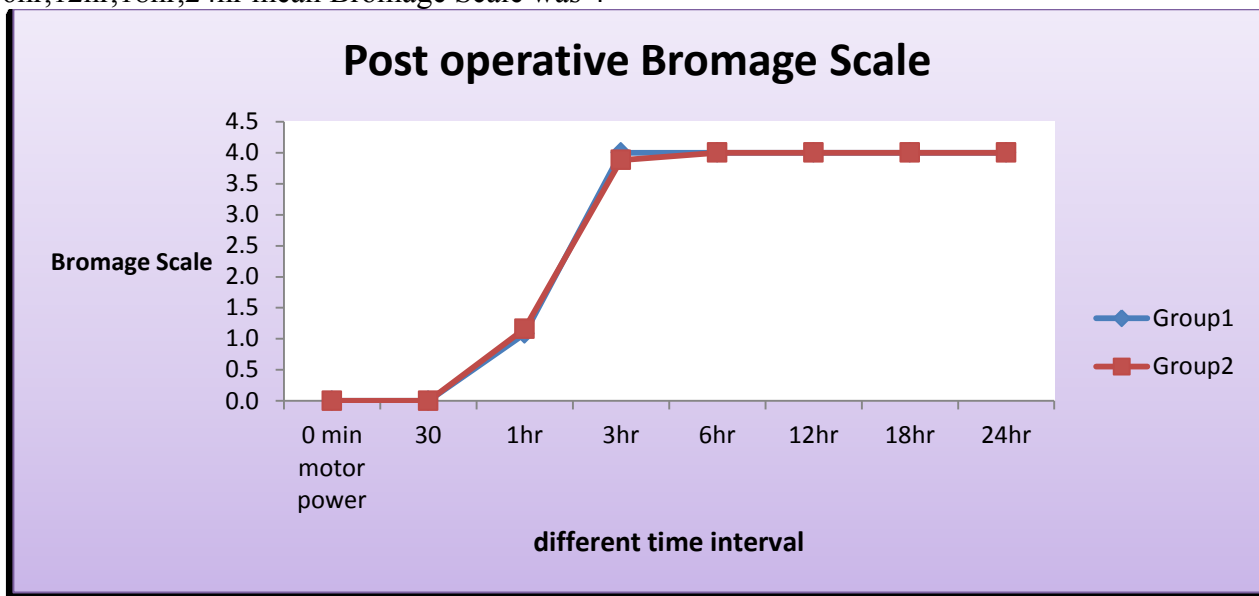
[vas4-6] and 3 patient with severe pain [vas7-9].

Postoperative visual analogue score at different time interval



Distribution of the cases according to postoperative Bromage Scale at different time interval among the groups

Postoperative mean Bromage Scale with standard deviation at various time points after surgery in both groups upto 24 hrs noted and found significantly higher mean was observed in group 2 as compared to group I at 1hr and at 0 and 30 min. Bromage Scale was 0 in both the groups and at 6hr,12hr,18hr,24hr mean Bromage Scale was 4



DISCUSSION

Nowadays, the regional techniques of brachial plexus block have been not only being used for surgical, but diagnostic and therapeutic purposes in interventional pain management also¹. It includes the blocking of the brachial plexus using local anaesthetic agents where it is most compactly arranged. It provides ideal conditions for surgery, maintains stable hemodynamics intraoperatively, decreases vasospasm, edema and postoperative pain along with early ambulation, return to work and other advantages of regional techniques which avoids general anaesthesia and its complications²⁵. The use of adjuvants to provide analgesia in regional anaesthesia since long. Morphine was injected perineurally in the mid nineteen's century. The studies of opioids for intrathecal anaesthesia was first published in 1901 and on epidural morphine in 1979. The presence of specific opioid receptors in the spinal cord and a segmental distribution of opioid analgesia were documented in the 70s. Many adjuvants have been used to improve the efficacy of regional analgesia, including NMDA antagonists (ketamine, magnesium), GABA agonists (midazolam) and adrenergic agonists (clonidine, adrenaline), COX-inhibitors (ketorolac), Acheesterase inhibitor (neostigmine) etc²⁶. In 1990, Johannssen et al studied the effect of a locally applied depot corticosteroid Methylprednisolone on the electrical properties of A fibres and C-fibres of plantar nerve in the anaesthetized rats. He found that corticosteroid suppressed the transmission in thin unmyelinated C fibres but not in myelinated A-beta fibres. This was a result of corticosteroid per se. The effect was reversed upon removing the corticosteroid, which suggested a direct membrane action²⁷.

This was probably the first demonstration of potential analgesic activity of corticosteroids, and paved the way for future research on this and other corticosteroids such as Dexamethasone, in the field of Pain management. Methylprednisolone 40 mg (commonly used in epidural steroid injections) was reported as being useful in prolonging brachial plexus (axillary

block) analgesia by about 7 hrs by Stan T et al in 2004¹⁴. The use of Dexamethasone in peripheral nerve blockade is probably based on the fact that methylprednisolone has been shown to specifically inhibit C-fiber transmission⁶⁶. Pain practitioners likely use dexamethasone more commonly because it is a pure liquid (ie, nonparticulate) steroid and also available in "preservative free" form¹⁵.

Limited research has been done regarding the effects of dexamethasone on postoperative pain. Most of available studies are done in dental surgery and tonsillectomy mainly. As regional analgesia adjunct, intravenous dexamethasone (8-10mg) has shown prolongation of IV regional anaesthesia¹⁵, and brachial plexus blocks¹⁶. During general anaesthesia, dexamethasone has shown reduction in pain from tonsillectomy in adults (10mg)¹⁷, and dental surgery (4-16mg)¹⁸. It is found to be more effective when used with a non-steroidal anti-inflammatory, particularly for tonsillectomy.¹⁹ In anorectal procedures, dexamethasone 4mg decreased hospital stay with no increase in wound related complications.²⁰ A study by Jeong Beom Lee et al in 2010 on the perioperative perineural Injection effect of dexamethasone and bupivacaine on a Rat Spared Nerve Injury Model, showed that preoperative infiltration of combination of dexamethasone and bupivacaine showed a significantly better analgesic effect than bupivacaine or dexamethasone alone in an SNI model, especially at the early stage after surgery. They suggested that analgesic effect of steroid is not only due to their anti-inflammatory action, but other effects as reversible local anesthetic action, stabilization of neural membranes, inhibition of neural peptide synthesis or action, suppression of ongoing or ectopic neural discharge and attenuation of sensitization of dorsal horn neurons are also important contributors.²⁸

We studied the effect of adding dexamethasone to bupivacaine plus lignocaine combination for axillary brachial plexus blockade in terms of onset time, duration of analgesia. Haemodynamic variables and rescue analgesic requirement in first 24 hours was also studied.

The mean age of patients in Group I and Group 2 were 29.60 ± 7.42 and 27.88 ± 7.33 years respectively which were comparable in both groups.

Weight distribution in all Groups was comparable with mean weight being 59.32 ± 7.116 kg and 59.16 ± 6.504 kg in Group I, Group 2 and respectively.

It was observed that there was no significant difference between sex ratio ($P = 0.724$) $p > 0.05$ in both group with male predominant in each group.

Most of the patients studied were from Deptt. of Hand Surgery of traumatic injury for the surgical repair.

The mean duration of surgery was in group 1 70.92 ± 15.69 minutes and in mean duration of surgery was in group 2 72.04 ± 17.86 minutes. No statistical significance was noted between the groups regarding duration of surgery in both groups.

The mean onset time for sensory block in Group I was 9.12 ± 1.394 (min), in Group 2 was 8.68 ± 1.887 (min) and the difference was statistically not significant between both groups ($p > 0.05$). Ali Movafegh et al. 2006 in their study, they found onset of sensory block similar in both groups. R.G. Pathak et al. 2012²⁹ in their study found onset of sensory block similar in both groups. Feroz Ahmed Dar et al. 2013³⁰ observed the sensory block faster in the dexamethasone group probably because they had used 0.5% ropivacaine.

The mean onset time of motor block for Group I was 11.80 ± 2.000 (min) for Group 2 was 11.08 ± 2.080 (min) and the difference was found to be statistically not significant between Group I and Group 2 ($p > 0.05$). This observation are similar with Movafegh A, et al¹⁶ 2006 they also did not find any significant difference in onset of motor block. Onset of motor block was similar in both the groups was observed by R.G. Pathak et al. 2012.²⁹ Similar observation was made by Parrington SJ, O'Donnell D, et al in 2010,²³ They concluded that the addition of dexamethasone to mepivacaine does not effect the onset of sensory and motor blockade.

The mean duration of sensory block in Group I was 222.52 ± 9.713 (min), in Group 2 was 794.52 ± 74.411 (min). p value was < 0.001 between both groups which was statistically significant. Similar observation was made by Castillo J, et al 1996¹¹ they concluded that Dexamethasone either incorporated in microspheres or added to the injection fluid containing suspended bupivacaine microspheres, increase the duration of both sensory and motor blockade compared with bupivacaine microsphere alone. Similar result also found in 2006 Movafegh A, et al¹⁶. they evaluated the duration of sensory blockade which was significantly longer in the dexamethasone group. Similar result also found in 2003 Shrestha BR, et al²¹ there was significant prolonged duration of analgesia in the dexamethasone group than in the control group. Similar result also found in 2009 Golwala MP, et al²² study there was markedly prolonged duration of analgesia in dexamethasone group. Similar result also found in Parrington SJ, O' Donnell D et al in 2010,²³ that the addition of dexamethasone to mepivacaine prolonged the duration of analgesia.

The mean duration of motor block in Group I was 180.68 ± 8.459 (min), in Group 2 was 203.20 ± 25.936 min. The p value was < 0.001 between both the Groups and found to be statistically significant. Similar observation was made by Castillo J, Curley J, Hotz J, et al 1996¹¹ and in 2006 by Movafegh A, et al¹⁶. They found that dexamethasone addition to lidocaine 1.5% solution in axillary brachial plexus block increased the duration of sensory and motor blockade.

In our study, we did not find any incidence of side effects such as nausea, vomiting, allergic reactions, hypotension, bradycardia in both the groups. None of our patients had pneumothorax.

The following results were obtained after statistical analysis:

The mean onset of sensory block for Group I was 9.12 ± 1.394 (min) for Group 2 was 8.68 ± 1.887 (min) and the difference was not

statistically significant between both groups ($p > 0.05$).

The mean onset of motor block for Group I was 11.80 ± 2.000 (min) for Group 2 was 11.08 ± 2.080 (min) and the difference was statistically not significant between Group I and Group 2 ($p > 0.05$).

The mean duration of sensory block in Group I was 222.52 ± 9.713 (min), in Group 2 was 794.52 ± 74.411 (min). p value was < 0.001 which was statistically significant. So, the mean duration of sensory block was significant prolonged in Group 2 as compared to Group I.

The mean duration of motor block in Group I was 180.68 ± 8.459 (min), in Group 2 was 203.20 ± 25.936 min. p value was < 0.001 between the both Groups and was statistically significant. So, the mean duration of motor block was significant prolonged in Group 2 as compared to Group I.

The mean time of rescue analgesia in Group I was 229.48 ± 8.09 (min), in Group 2 was 801.80 ± 71.83 (min). The p value was < 0.001 statistically significant. So, duration of analgesia was significant prolonged in Group 2 as compared to Group I.

There was no significant incidence of nausea, vomiting, allergic reactions, hypotension, bradycardia, in the intra operative and post operative period in all the groups.

The diabetic patients may experience hyperglycaemia and patients with a continuing infectious process can be affected by the anti inflammatory effects of steroids. The admixture of dexamethasone with a local anaesthetic agent may be useful in situations in which epinephrine must be used with caution (e.g. hypertension IHD, etc.)

CONCLUSION

Addition of dexamethasone (2ml) to local anaesthetic mixture for axillary brachial plexus block was found highly effective in prolongation of duration of anaesthesia and post operative analgesia. It decreases the rescue analgesic consumption and VAS score postoperatively without any potential side effects.

REFERENCES

1. Stephen E. Abram, "Chronic pain management", In: Barash PG, Cullen BF, Stoelting RK. Clinical Anaesthesia, 5th ed. Lippincott Williams and Wilkins, Philadelphia. 2006:1449
2. Atkinson RS, Rushwan GB, Lee AJ, "Regional technique. Chapter 31. Synopsis of Anaesthesia", 10th ed: 593-4.
3. Raj PP, "Historical aspects of regional anaesthesia", Chapter 1. In: Text Book of Regional Anaesthesia; 1st ed. 2002 May, page 3.
4. Merlin D. Larson, "History of Anesthetic Practice", chapter 1, in Miller's Anesthesia edited by Ronald D. Miller 7th ed., page 17-23.
5. Wakhlo R, Gupta V, Raina A, Gupta SD, Lahori VU. Supraclavicular Plexus Block: Effect of Adding Tramadol or Butorphanol as an Adjuncts to Local Anaesthetic on Motor and Sensory Block and Duration of Post-operative Analgesia. *J Anaesth Clin Pharmacol* 2009; 25(1): 17-20.
6. Gabriella I, Adnane M, Desire-Pascal D. The effects of clonidine added to mepivacaine for paronychia surgery under axillary brachial plexus block. *Anesth Analg* 2005; 100(4):1179-1183.
7. Lalla RL, Anant S, Nanda HS. Verapamil as an Adjunct to Local Anaesthetic for Brachial Plexus Blocks. *MJAFI* 2010; 66: 22-24.
8. Benzon HT. Epidural steroids. In: Raj PP, editor. Pain medicine, a comprehensive review. UK: Mosby Publications; 1999. p.259-263.
9. Glasser RS, Kneego RS, Delashaw JB, Fessler RG. The perioperative use of corticosteroids and bupivacaine in the management of lumbar disc disease. *J Neurosurg* 1993; 78: 383-7.
10. Mirzai H, Tekin I, Alincak H. Perioperative use of corticosteroid and bupivacaine combination in lumbar disc surgery: a randomized controlled trial. *Spine* 2002; 27: 343-6.
11. Castillo J, Curley J, Hotz J. Glucocorticoids prolong rat sciatic nerve blockade in vivo from

- bupivacaine microspheres. *Anesthesiology* 1996;85:1157-66.
12. Droger C, Benziger D, Gao F, Berde CB. Prolonged intercostals nerve blockade in sheep using controlled-release of bupivacaine and dexamethasone from polymer microspheres. *Anesthesiology* 1998; 89:969-74.
13. Kopacz DJ, Lacouture PG, Wu D. The dose response and effects of dexamethasone on bupivacaine microcapsules for intercostals blockade(T9 to T11)2003; 96:576-82.
14. Stan T, Goodman E, Cardida B, Curtis RH. Adding methylprednisolone to local anesthetic increases the duration of axillary block. *RegAnesth Pain Med* 2004; 29: 380-382.
15. Movafegh A, Razazian M, Hajimaohamadi F, Meysamie A. Dexamethasone added to lidocaine prolongs axillary brachial plexus blockade. *AnesthAnalg* 2006; 102: 263-7
16. McKean S, Kochilas X, Kelleher R, Dockery M. Use of intravenous steroids at induction of anaesthesia for adult tonsillectomy to reduce post-operative nausea and vomiting and pain: a double-blind randomized controlled trial. *Clinical Otolaryngology* 2006; 31(1):36-40.
17. Baxendale BR, Vater M, Lavery KM. Dexamethasone reduces pain and swelling following extraction of third molar teeth. *Anaesthesia* 1993; 48(11):961-4.
18. Aghy P, Hall SJ. Dexamethasone reduces pain after tonsillectomy in adults. *Clinical Otolaryngology & Allied Sciences* 2002; 27(5):321-6.
19. Coloma M, Duffy LL, White PF, Kendall Tongier W, Huber PJ Jr. Dexamethasone facilitates discharge after outpatient anorectal surgery. *Anesthesia & Analgesia* 2001; 92(1):85-8.
20. Liu K, Hsu CC, Chia YY. Effect of dexamethasone on postoperative emesis and pain. *British Journal of Anaesthesia* 1998; 80(1):85-6.
21. Shrestha BR, Maharjan SK, Gautam B, Joshi MR. Comparative study between tramadol and dexamethasone as an admixture to bupivacaine in supraclavicular brachial plexus block. *J Nepal Med Assoc* 2007;46(168): 158-64.
22. Golwala MP, Swadia VN, Dhimar AA, Sridhar NV. Pain Relief by Dexamethasone as an Adjuvant to Local Anaesthetics in Supraclavicular Brachial Plexus Block. *J Anaesth Clin Pharmacol* 2009;25(3): 285-288
23. Parrington SJ, O'Donnell D, Chan VWS. Dexamethasone added to mepivacaine prolongs the duration of analgesia after supraclavicular brachial plexus blockade. *RegAnesth Pain Med* 2010; 35: 422-6
24. L. F. R. Falcao, M. V. Perez. Minimum effective volume of 0.5% bupivacaine with epinephrine in ultrasound-guided interscalene brachial plexus block *BJA*, November 29, 2012: Page 1 of 6.
25. Paul F White and Alejandro Racart Freire. *Regional Anaesthesia. Miller's 6th edition; vol-2: 2608*
26. Lennart Christiansson. Update on Adjuvants in Regional Anaesthesia. *Periodicum Biologorum* Vol. 111, No 2, 2009, 161-170.
27. Johansson A, Hao J, Sjölund B. Local corticosteroid application blocks transmission in normal nociceptive C-fibres. *Acta Anaesthesiol Scand.* 1990 Jul;34(5):335-8.
28. Lee JB, Choi SS, Ahn EH, Hahm KD, Suh JH, Leem JG, Shin JW. Effect of perioperative perineural injection of dexamethasone and bupivacaine on a rat spared nerve injury model. *Korean J Pain.* 2010 Sep;23(3):166-71. doi: 10.3344/kjp.2010.23.3.166. Epub 2010 Aug 26.
29. R.G. Pathak et al. Supraclavicular brachial plexus block with and without dexamethasone – A comparative Study. *International Journal of Scientific and Research Publication*, volume 2, Issue 12 Dec. 2012 ISSN 2250-3153.
30. Feroz Ahmad Dar et al. Effect of addition of dexamethasone to ropivacaine in supraclavicular brachial plexus block. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*. Volume 10, Issue 4, Sep.-Oct. 2013, pp. 01-05.