Section A-Research paper
ISSN 2063-5346

Comparative study of 0.5% bupivacaine with 2 ml of 10% magnesium sulphate and 0.5% bupivacaine with 2 ml of 7.5 % sodium bicarbonate for popliteal nerve block for ankle and foot surgeries

First Author: Dr Viditha Korukonda, Associate Professor Department of Anaesthesiology, Kamineni Academy of Medical Sciences and Research Center Hyderabad, INDIA.

Second Author: Dr Karri Laxmi Priyanka, Associate Professor, Department of Anesthesiology, Kamineni Academy of Medical Sciences and Research Centre, L B Nagar, Hyderabad, INDIA.

Third Author: Dr S. Samanth Reddy, Associate Professor, Kamineni Academy of Medical Sciences and Research Centre, L B Nagar, Hyderabad, INDIA.

Fourth And Corresponding Author: Dr. Naveen Kumar Neerudu, Associate Professor, Department of Anesthesilogy, TRR Institute of Medical Sciences, Inole, Patancheru, Sangareddy, INDIA.
Email: neeradu@yahoo.com

Received Date: 18/06/2023 Revised Date: 20/07/2023 Accepted Date: 10/08/2023

Abstract

Background: Popliteal nerve block is a useful technique for ankle and foot surgeries, particularly in patients thought unsuitable for central neuraxial block. Agents such as magnesium and clonidine are used as adjuvants to local anaesthetics in peripheral nerve blockade. The present study is taken up to compare the clinical efficacy of 20 ml of 0.5% bupivacaine with 2 ml of 10% magnesium sulphate and 20 ml of 0.5% bupivacaine with 2 ml of 7.5% sodium bicarbonate for popliteal nerve block. **Material and Methods:** Present study was hospital based prospective, randomised clinical study, conducted in patients Aged between 18-70 years, ASA physical status I, II and III of either sex, posted for elective ankle and foot surgeries. 60 patients were randomly divided into 2 groups as Group M (Magnesium Sulphate) & group S (Sodium Bicarbonate). **Results:** There were no statistically significant differences between these groups in demographics, ASA grading and the type of surgeries. The time of onset of sensory level block in Group S was 12.73±1.33(in mins) and in Group M was 16.83±1.66(in mins), difference was statistically significant. The duration of sensory level block in Group S was 13.48±1.29(in hours) and in Group M was 17.96±1.95(in hours), difference was statistically significant. The time of onset of motor block in Group S was 16.13±1.59 (in mins) and in Group M was 24.37±1.40(in mins) , difference was statistically significant. The duration of motor level block in Group S was 7.43±0.88(in hours) and in Group M was 10.35±0.81(in hours), difference was statistically significant. **Conclusion:** Both magnesium sulphate and sodium bicarbonate do not cause any hemodynamic instability, adverse effects or complications and provide excellent intra operative anaesthesia with post operative analgesia.

Keywords: Bupivacaine, soda bicarbonate, magnesium sulphate, popliteal

Introduction: The effectiveness of anaesthesia techniques has an important role in increasing the ambulatory orthopaedic and surgical procedures. Regional anaesthesia techniques are used frequently as an alternative to general anaesthesia in these procedures.[1] Foot and ankle surgery is accompanied by pain for the first few days following surgery, opioid based postoperative pain management can lead to inadequate pain relief and is accompanied by side effects.[1]

Popliteal nerve block is a useful technique for ankle and foot surgeries, particularly in patients thought unsuitable for central neuraxial block. It is also associated with added advantage of early post operative mobility, avoidance of post dural puncture headache, can be used readily after head injury where central neuraxial block is relatively contraindicated.[2,3]

Long-acting local anaesthetics (LA) are commonly used for popliteal nerve block as they provide prolonged post operative analgesia and bupivacaine is the most commonly usedLA for this purpose. Agents such as magnesium and clonidine are used as adjuvants to local anaesthetics in peripheral nerve blockade.[4] The present study is taken up to compare the clinical efficacy of 30 ml of 0.5% bupivacaine with 2 ml of 10% magnesium sulphate and 30 ml of 0.5% bupivacaine with 2 ml of 7.5% sodium bicarbonate for popliteal nerve block.

Material And Methods

Present study was hospital based prospective, randomised clinical study, conducted in department of anaesthesiology, at Kamineni academy of medical sciences and Research centre Hyderabad, India. Study duration was of 2 years (November 2021 to April 2023). Studyapproval was obtained from institutional ethical committee.

Inclusion criteria:Patients Aged between 18-70 years, ASA physical status I, II and III of either sex, posted for elective ankle and foot surgeries, Willing to participate in present study Exclusion criteria

- Patients with known hypersensitivity or contraindications to the study drugs
- Infection at the site of block
- Patients with advanced renal, hepatic, respiratory or cardiac diseases
- Patients with severe coagulopathy
- Pregnant patients
- Patients with neurological, psychiatric or neurovascular disorders
- Patient with alcohol/drug abuse
- Patient refusal

An informed consent was obtained from all patients and detailed pre anaesthetic evaluation was done on the previous day of surgery. 60 patients were randomly divided into 2 groups using simple sealed opaque envelope method with 30 patients in each group (n=30). Group M: received 20ml of Inj Bupivacaine 0.5% with 2ml 10% Magnesium Sulphate Group S : received 20ml of Inj Bupivacaine 0.5% with 2ml 7.5% Sodium Bicarbonate

All patients were nil per orally for 6 hours for solids and 2 hours for liquids prior to surgery. Tab Alprazolam 0.25mg and Tab Ranitidine 150 mg was given on the previous night of surgery. Anaesthesia machine was checked and all the drugs and equipments necessary for emergency resuscitation was kept ready. On receiving the patient in operating room, a wide

bore intravenous line was secured with 18-gauge (G) cannula. Monitoring for electrocardiography(ECG), heart rate(HR), arterial pulse saturation (SpO2) and noninvasive blood pressure(NIBP) was done for all patients. The patient was placed in the

lateral position on the operating bed. The popliteal nervewas located using ultrasound with linear probe.

After negative aspiration for blood, test solution (20ml of 0.5% bupivacaine with either 10% Magnesium Sulphate 2ml or Sodium Bicarbonate 1ml) was injected. Time of completion of injection was taken as time zero. Test drug was prepared and loaded in two 10ml syringes with one syringe having either 10% Magnesium Sulphate 2ml or 7.5% Sodium Bicarbonate 2ml by an anaesthesiologist who is not involved in the study. All the blocks wasperformed by the same investigator.

Immediately following popliteal nerve block patients were placed in supine position. Onset of sensory and motor block, duration of blocks, quality of block were observed and noted. Patients were assessed for haemodynamic parameters every 5 minutes till the completeonset and also at the end of surgery. Patients were monitored for any signs and symptoms ofcardiovascular (changes in heart rate, rhythm) and central nervous system toxicity. They were also monitored for signs of hypersensitivity reactions to local anaesthetic drugs. Patient satisfaction with the anaesthetic technique was recorded by asking the patient and surgeon toassess the block as: very good, good, medium or poor. In the post operative period, the pain was assessed by Visual Analogue Score. For statistical purpose patients with unsatisfactory block will be excluded from the study.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi-square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

Results

There were no statistically significant differences between these groups in demographics, ASA grading and the type of surgeries.

Table 1: General characteristics

Characteristics	**Group S**	**Group M**	**Total**	**P value**
Age in years				
<20	1(3.3%)	0(0%)	1(1.7%)	0.589
20-30	3(10%)	3(10%)	6(10%)	
31-40	7(23.3%)	3(10%)	10(16.7%)	
41-50	4(13.3%)	9(30%)	13(21.7%)	
51-60	7(23.3%)	7(23.3%)	14(23.3%)	
61-70	7(23.3%)	7(23.3%)	14(23.3%)	
>70	1(3.3%)	1(3.3%)	2(3.3%)	
Mean ± SD	48.70±14.69	50.70±13.80	49.70±14.17	
Gender				
Female	8(26.7%)	12(40%)	20(33.3%)	0.273
Male	22(73.3%)	18(60%)	40(66.7%)	
Weight (kg)	64.40±7.93	65.60±7.35	65.00±7.60	0.546
ASA Grade				
I	5(16.7%)	5(16.7%)	10(16.7%)	0.958
II	16(53.3%)	15(50%)	31(51.7%)	
III	9(30%)	10(33.3%)	19(31.7%)	
Premedication				
inj midazolam	12(40%)	12(40%)	24(40%)	1

Inj Propofol	1(3.3%)	3(10%)	4(6.7%)	0.612

The time of onset of sensory level block in Group S was 12.73±1.33(in mins) and inGroup M was 16.83±1.66(in mins), difference was statistically significant.

TABLE 2: Onset of sensory block

Onset of sensory block (in mins)	**Group S**	**Group M**	**Total**	**P value**
6-10	0	0	0	0.0001
11-15	29 (96.66%)	8 (26.66%)	37 (61.66%)	
16-20	1 (3.33%)	22 (73.33%)	23 (38.33%)	
Mean	12.73±1.33	16.83±1.66	14.76±2.51	<0.001**

The duration of sensory level block in Group S was 13.48±1.29(in hours) and in Group M was 17.96±1.95(in hours), difference was statistically significant.

TABLE 3: Duration of sensory Block

Duration of sensory Block in hrs.	**Group S**	**Group M**	**Total**	**P value**
<12	2(6.9%)	0(0%)	2(3.4%)	
12-24	27(93.1%)	29(100%)	56(96.6%)	
>24	0(0%)	0(0%)	0(0%)	
Mean duration	13.48±1.29	17.96±1.95	15.75±2.79	<0.001**

The time of onset of motor block in Group S was 16.13±1.59 (in mins) and in GroupM was 24.37±1.40(in mins), difference was statistically significant.

TABLE 4: Time of Onset of motor block

Onset of motor block (in mins)	**Group S**	**Group M**	**Total**	**P value**
<15	4 (13.33%)	0	4 (13.33%)	<0.001**
16-20	26 (86.66%)	0	26 (86.66%)	
>20	0	30 (100%)	30	
Mean	16.13±1.59	24.37±1.40	20..25±4.40	<0.001**

The duration of motor level block in Group S was 7.43±0.88(in hours) and in Group M was10.35±0.81(in hours), difference was statistically significant.

TABLE 5: Duration of motor block

Duration of motor block in hrs.	**Group S**	**Group M**	**Total**	**P value**
<8	19(65.5%)	0(0%)	19(32.8%)	
8-10	10(34.5%)	13(44.8%)	23(39.7%)	
>10	0(0%)	16(55.2%)	16(27.6%)	
Total	7.43±0.88	10.35±0.81	8.89±1.69	<0.001**

Visual Analogue Scale was used for post operative pain assessment in all the 60 patients at time intervals of 2hrs, 4hrs, 6hrs, 8hrs, 12hrs and 24hrs. For up to 6 hours after surgery the VAS for both the groups were similar with the values not being statistically significant. At 8 hours after surgery where Group S showed a mean VAS of 1.28±0.45 and Group M showed a mean VAS of 1.00±0.00, difference was statistically significant. At 12 hrs. after

surgery, Group S showed a mean VAS of 1.93 ± 0.37 and Group M recorded a mean VAS of 1.07±0.37, difference was statistically significant. VAS assessed at 12 hours after surgery for both the groups were not statistically significant.

TABLE 6: Visual analog scale

Visual analog scale	Group S	Group M	Total	P value
2 hour	0.00±0.00	0.00±0.00	0.00±0.00	-
4 hour	0.59±0.50	0.41±0.50	0.50±0.50	0.196
6 hour	0.87±0.35	0.73±0.45	0.80±0.40	0.203
8 hour	1.28±0.45	1.00±0.00	1.14±0.35	0.002**
12 hour	1.93±0.37	1.07±0.37	1.50±0.57	<0.001**
24 hour	3.13±0.73	2.93±0.58	3.03±0.66	0.246

3 patients each from Group S (3.3%) and Group B (10%) had nausea and vomiting post operatively. 1 patient from Group S and 2 patients from Group M had vascular puncture.No infection, nerve injury & respiratory depression noted in any group.

TABLE 7: Side effects

Side effects	Group S	Group M	Total	P value
Vascular puncture	1(3.3%)	2(6.7%)	3(5%)	1.000
Hypersensitivity	1(3.3%)	0(0%)	1(1.7%)	1.000
PONV	3(10%)	3(10%)	6(10%)	1.000

All 60 patients from both the groups were very satisfied with the procedure, quality of information provided, courtesy of staff and analgesia, difference was statistically significant.**TABLE 8: Patient satisfaction score**

Patient satisfaction score (out of 5)	Group S	Group M	Total	P value
Courtesy of staff	4.38±0.94	4.62±0.68	4.50±0.82	0.267
Quality of information	4.28±0.70	4.00±0.65	4.14±0.69	0.127
Procedure satisfaction	4.52±0.63	4.48±1.06	4.50±0.86	0.881
Analgesia	4.79±0.41	4.69±0.47	4.74±0.44	0.377

Discussion

Regional anaesthesia techniques are used frequently as an alternative to general anaesthesia in Ankle and Foot surgery. These surgeries are accompanied by pain for the first few days following surgery. Opioid based postoperative pain management can lead to inadequate pain relief and is accompanied by side effects.[1]

Popliteal nerve block is a useful technique for ankle and foot surgeries, particularly inpatients thought unsuitable for central neuraxial block. It also avoids complications in the elderly patients who are particularly prone for haemodynamic changes leading to increased morbidity and mortality. Studies by Ayman A et al.,[1] Singelyn FJ et al.,[5] and R. Arcioni et al.,[6] have shown an added advantage of popliteal nerve block in early post operative mobilitywhich is essential in surgical procedures.

The efficacy of the alkalinised local anaesthetic solution was showed on quicker onset of anaesthesia and less injection pain not only in peripheral nerve blocks but also in various regional anaesthesia techniques such as intraoral or inferior alveolar nerve blocks. Kosucu, Muge et al.,[8] showed that addition of 8.4% sodium bicarbonate to the syringe at the precise moment of the procedure in specific concentrations and proportions before the regional technique is performed will not precipitate the drug.

Magnesium has a role in various physiological processes that include vascular tone, transmembrane ion flux, control of calcium channel gating, neuronal activity, heart excitability, and neurotransmitter release.[8] It is proved that the addition of magnesium sulphate to local anaesthetics for neuraxial anaesthesia improves the quality of analgesia and prolongs the duration of anaesthesia.[9] Magnesium acts directly on peripheral nerves[7] and the antinociceptive effect of magnesium is related to its calcium antagonist and N-methyl d- aspartate receptor blocking effect.[4]

In our study we found that Group S patients who received Sodium bicarbonate as additive provided faster onset of sensory level blockage (12.73 ± 1.33 mins) compared to Group M (16.83 ± 1.66 mins) , difference was statistically significant. Duration of sensory level block in Group M was higher (17.96±1.95 hours) than Group S (13.48±1.29 hours), , difference was statistically significant. Our results were comparable to a study conducted by Alzeftawy AE et al.,[10] where magnesium sulphate prolongs the duration of action of sensoryblock when added to Inj Bupivacaine.

Group S patients had faster onset of motor level blockage (16.13±1.59 mins) compared to Group M (24.37 ± 1.40 mins), difference was statistically significant. However the duration of motor level block in Group M was higher (10.35±0.81 hours) compared to Group S (7.43±0.88 hours), , difference was statistically significant. Our results were in agreement with a study conducted by Alzeftawy AE et al.,[10] where magnesium sulphate prolongs the duration of action of motor block.

In comparison to study conducted by Sun J, .,[11] magnesium sulphate in our study provided longer duration of sensory and motor block with good post operative analgesia however the onset of action was delayed.

Visual Analogue Scale up to 6 hours after surgery the VAS for both the groups were similar with the values not being statistically significant. At 8 hours after surgery where Group S showed a mean VAS of 1.28±0.45 and Group M showed a mean VAS of 1.00±0.00, difference was statistically significant. At 12 hrs. after surgery, Group S showed a mean VAS of 1.93 ± 0.37 and Group M recorded a mean VAS of 1.07±0.37, difference was statistically significant. VAS assessed at 12 hours after surgery for both the groups were not statistically significant. Similar results were obtained by a study conducted by Alzeftawy AE et al.,[10] where magnesium sulphate prolongs the duration of action of sensory block when added to Inj Bupivacaine which was measured by VAS.

In our study, the means of assessing postoperative analgesia was the time to first analgesic administration, the total amount of analgesic consumed in the first 24 hour period after surgery and the VAS at different time in first 24 hour. In both the groups all 60 patients did not ask for analgesia post operatively, since we assessed for pain only at rest and not on movement. Both the groups had excellent post operative analgesia with mean VAS scores of
<4 even at 24 hours after surgery . Rangel Vde O et al.,[12] showed that the approach for tibial and common fibular nerves with single puncture in the popliteal fossa using peripheral nervestimulator is a good option for anesthesia and analgesia for foot surgeries.

Gallardo J et al.,[13] conducted a study which showed that VAS evaluation had a significant improvement in pain control in the group with the popliteal block after 6, 12, 18, and 24 hours post surgery, with pain levels peaking and being most different between 6 and 12 hours post surgery and also exhibited a significantly lower consumption of morphine and a greater degree of patient satisfaction.

We completely agree with Gallardo J et al.,[13] because in our study VAS evaluation had a significant pain control in both groups up to 12 hours and patients from both the groups showed a high rate of satisfaction with the procedure and demonstrated a good discharge disposition. No significant difference in satisfaction could be detected between

the 2 groups in the study. We also did not observe any anaesthesia related complications in all the 60 patients who underwent popliteal nerve block for the proposed surgical procedures.

Limitations of present study were small sample size, plasma levels of soda bicarbonate and magnesium sulphate were not established & block was administered with the help of a peripheral nerve stimulator.

Conclusion

Bupivacaine with soda bicarbonate as additive has a faster onset of sensory and motor blockade compared to bupivacaine with magnesium sulphate as additive. Bupivacaine with magnesium sulphate provides longer duration of sensory analgesia and motor blockade when compared to Bupivacaine with soda bicarbonate. Both magnesium sulphate and sodium bicarbonate do not cause any hemodynamic instability, adverse effects or complications and provide excellent intra operative anaesthesia with post operative analgesia.

Conflict of Interest: None to declare
Source of funding: Nil

References

1. Ayman A. El Sayed The effect of adding magnesium to bupivacaine for popliteal nerve block on anesthesia and postoperative analgesia in achilles tendon repair patients: a randomized double-blinded study Ain-Shams Journal of Anaesthesiology 2016, 9:409–415
2. Greengrass RA, Klein SM, D'Ercole FJ, Gleason DG, Shimer CL, Steele SM Lumbar plexus and sciatic nerve block for knee arthroplasty: comparison of ropivacaine and bupivacaine. Can J Anaesth 1998;45:1094–1096
3. Connolly C, Coventry DM, Wildsmith JA. Double-blind comparison of ropivacaine 7.5mgml(j1) with bupivacaine 5mg ml(j1) for sciatic nerve block Br J Anaesth 2001;86:674–677
4. Gunduz A1, Bilir A, Gulec S Magnesium added to prilocaine prolongs the du- ration of axillary plexus block Reg Anesth Pain Med 2006;31:233–236.
5. Singelyn FJ, Gouverneur JM, Gribomont BF. Popliteal sciatic nerve block aided by a nerve stimulator: a reliable technique for foot and ankle surgery. Reg Anesth 1991;16:278–281.
6. R. Arcioni, S. Palmisani, M. Della Rocca et al Lateral popliteal sciatic nerve block: A single injection targeting the tibial branch of the sciatic nerve is as effective as a double-injection technique Acta Anaesthesiol Scand 2007;51:115–121
7. Kosucu, Muge & Ulusoy, Hulya & Erciyes, Nesrin & Topbas, Murat & Turhan, Ahmet. The Effects of Alkalinization of 0.5% Ropivacaine by Adding Sodium Bicarbonate on Block Onset, Ending Time and Quality, and Postoperative Analgesic Efficiency for Peripheral Nerve Block in Unilateral Extremity Surgery. Turkiye Klinikleri Journal of Medical Sciences 2013;33:326-333.
8. Choyce A, Peng P. A systematic review of adjuncts for intravenous regional anesthesia for surgical procedures. Can J Anaesth. 2002;49:32–45.
9. Hwang JY, Na HS, Jeon YT, Ro YJ, Kim CS, Do SH. I. V. infusion of magne- sium sulphate during spinal anaesthesia improves postoperative analgesia. Br J Anaesth 2010;104:89–93.
10. Alzeftawy AE, El-Daba AA. Cold bupivacaine versus magnesium sulfate added to room temperature bupivacaine in sonar-guided femoral and sciatic nerve block in arthroscopic anterior cruciate ligament reconstruction surgery. Anesth Essays Res 2016;10:667-73

11. Sun J, Feng X, Zhu Q, Lin W, Guo H, Ansong E, Liu L. Analgesic effect of perineural magnesium sulphate for sciatic nerve block for diabetic toe amputa- tion: A randomized trial. PLoS One. 2017 May 2;12(5):e0176589.
12. Rangel Vde O, Carvalho Rde A, Mandim BL, Alves RR, Ruzi RA, et al. (2011) Tibialand common fibular nerve block in the popliteal fossa with single punc- ture using percutaneous nerve stimulator: anatomical considerations and ultra- sound description. Revista Brasileira de Anestesiologia 61: 533-543.
13. Gallardo J, Lagos L, Bastias C, Henríquez H, Carcuro G, et al. (2012) Contin- uous popliteal block for postoperative analgesia in total ankle arthroplasty. Foot Ankle Int 33: 208-212.