EFFICACY OF ULTRASOUND WITH NEUROSTIMULATION COMPARED WITH ULTRASOUND GUIDANCE ALONE FOR BRACHIAL PLEXUS BLOCK IN UPPER LIMB SURGERIES

Dr. Shalley Singh
Senior Resident, School of Medical Sciences & Research, Sharda University.

Dr. Manish Kumar Agarwal
Associate Professor, School of Medical Sciences & Research, Sharda University.

Dr. Poonam Singh
Assistant Professor, School of Medical Sciences & Research, Sharda University.

Dr Abhinandan Borah
Senior Resident, School of Medical Sciences & Research, Sharda University.

Dr. Ashok Kumar Sethi
Professor, School of Medical Sciences & Research, Sharda University.

***Corresponding author: Dr. Manish Kumar Agarwal,** Associate Professor, School of Medical Sciences & Research, Sharda University.
Email: dr.manishagarwal09@gmail.com

Abstract

Pain is an unpleasant result that is related with considerable psychological and physiological changes that occur during surgical procedures and the recovery period that follows them. For a total period of 18 months, beginning January 2020 and continuing through June 2021, a prospective study with randomised control was carried out at Operation theatre for routine orthopaedic and surgical procedures as well as a high dependency unit at Sharda University's SMS&R. The technique uses a computer-generated sequence of random numbers as well as a sealed envelope.

In comparison to the ultrasound group, the success rate of motor blockage was significantly higher in the ultrasound group that included peripheral nerve stimulation. Although the mean amount of time required to conduct the block—that is, the amount of time required for the procedure—was 18.94 minutes in the group USG with PNS, the amount of time required was only 8.73 minutes in the group US. Both groups experienced a similar onset of the sensory blockage. In comparison to the USG group, the USG+ PNS group saw an earlier onset of motor blockage within the first 10 minutes (93.3 percent versus 20 percent, p 0.001) When compared to the USG group, the total length of blockade in the USG+PNS group was considerably longer (392.8631.48 minutes vs. 325.8856.64 minutes, p0.001) When compared with the ultrasound group, the peripheral nerve

stimulator group had a higher quality block and an earlier onset of symptoms than the ultrasound group.

Keywords: Nerve stimulator, supraclavicular block, ultrasound guidance, brachial plexus, upper limb

Introduction

Pain is an unpleasant result that is related with considerable psychological and physiological changes that occur during surgical procedures and the recovery period that follows them. This can be remedied by utilising the appropriate medications and treatment methods. Both for stand-alone anaesthesia and as analgesic supplements for intraoperative and postoperative care, regional anaesthetic procedures offer a number of benefits not found in other types of anaesthesia (Klaastad et al., 2009).

In 1912, Kulenkampff was the first person to successfully conduct and describe the brachial plexus block, which is now a frequent procedure used to deliver anaesthesia for arm, forearm, and hand surgeries (Kulenkampff., 1928). The tip of the needle needs to be in close proximity to or make direct touch with a nerve in order to create the best possible block. During this period, the patient may have paraesthesia in the arm, forearm, hand, or fingers (Grey, 2010). The supraclavicular technique is regarded as the most straightforward method of performing a brachial plexus block, in addition to being one of the most successful. Because it is a blind procedure, the traditional method, which involves applying the paraesthesia technique, may be associated with a higher rate of failure as well as harm to the nerves and vascular structures (Carty., 2007). As a means of mitigating a number of these issues, the utilisation of peripheral nerve stimulators was initiated. These devices enabled improved localisation of the plexus by the observation of the evoked motor response (Fanelli et al., 1999; Mak PH et., 2001). (Haleem et al., 2010; Sathyan et al., 2014) A nerve stimulator that is linked to a suitable needle makes it possible to emit a low intensity electric current from the needle tip when it is close to or in contact with the motor nerve. This causes the innervated muscle to contract in a manner that is characteristic of the contraction (Haleem et al., 2010; Sathyan et al., 2014). Although the use of a nerve stimulator to pinpoint the brachial plexus resulted in blocks that were more effective and reliable, the danger of repercussions was still high (Bhatnagar et al., 2020). This technique of stimulating nerves in order to provoke a motor response is also known as a form of neurostimulation.

However, there is a possibility that this method is not infallible, as there is a continuing risk of injury to the structures that are nearby, particularly the vascular structures, nerves, and pleura, which could result in pneumothorax (Hanumanthaiah et al., 2013; McClure et al., 2003). The use of ultrasound technology for the precise localization of nerves and plexus has revolutionised the field of regional anaesthesia, which has led to the successful testing of ultrasound probes with a variety of frequencies. The success rate of the supraclavicular brachial plexus block has increased because to the use of ultrasound, which also allows for excellent localization and has enhanced the safety margin (Brown et al., 1993). It has also been reported that the use of combined

ultrasonography and neurostimulation results in a decreased total time required for achieving the outcomes in the form of time to perform the block and onset time as compared to the use of ultrasound guidance alone. This is an advantage over the use of ultrasound guidance alone.

Ultrasound guided peripheral nerve block is a sophisticated procedure in which internal tissues, including nerves to be blocked are non-invasively visualized under a image produced by ultrasound. Under USG direction, an accurate needle position distributes local anaesthetic medication to the correct location on the nerves (Williams et al., 2003; Alfred et al., 2018).

There is considerable lacunae and gape in the existing knowledge as regards to comparison of efficacy of ultrasound with neurostimulation versus ultrasound guided brachial plexus block. Only recent very few studies have been done hence the present study aimed to assess the efficacy of two different techniques of brachial plexus block by supraclavicular route, namely, ultrasonography with neurostimulation and ultrasound guidance alone for surgical anaesthesia and post-operative analgesia.

Materials & Methods

A Randomized Controlled Trial in the Future The research was carried out over the course of 18 months, beginning in January 2020 and continuing through June 2021. Operation theatre for routine orthopaedic and surgical procedures as well as a high dependency unit at Sharda University's SMSR. The technique uses a computer-generated sequence of random numbers as well as a sealed envelope. Patients who were set to undergo elective surgery on their upper limbs made up the study population. The sample size was calculated to be 30 patients in each group, for a total of 60 patients during the entire trial. This was based on a statistical power of 0.8 and a type 1 error rate of 5%. Patients of either gender, aged between 18 and 60 years, and classified as ASA grade I or II were considered for participation. Patients who refused treatment, were known to have an allergic reaction to local anaesthetics, had coagulopathy, or had an infection at the site of the block were not considered. The Institutional Ethical Committee gave its stamp of approval to the study's protocol. They were randomly divided into two groups using a computer-generated sequence of random numbers and a technique involving sealed envelopes. The groups had a size of n = 30 members each and were given the names group A and group B. The participant took the envelope, and the number was recorded in the appropriate column of the proforma chart. After that, the observer was kept in the dark regarding the method by which the block was carried out while the investigator carried out the block, and then the observer was given permission to record the results. After the study was finished, the proforma chart was shown to the participants. A supraclavicular brachial plexus block was performed on Group A using a combination ultrasound and peripheral nerve stimulator (USG+PNS). Group B was designated to receive a supraclavicular brachial plexus block that was ultrasonography (USG) guided alone.

The day before their surgeries, all of the patients were put through a comprehensive pre-anesthetic evaluation after all of the standard investigations were completed. All of the systems, including the airway and the surface anatomy of the area where the block was going to be conducted, were inspected, and the process that was going to be followed was outlined. They were given information regarding the experience of paresthesia. The patients' concerns were allayed by the provision of reassurance. In accordance with the fasting instructions, none of the patients were allowed to consume anything by mouth.

Assessment of parameters:

Block Execution Time:

Group A (USG + PNS): The amount of time that passes between the initial scanning done to locate the plexus and the insertion of the PNS needle, which is then followed by contractions in the muscles of the upper limb, and finally the removal of the needle at the conclusion of the procedure after the drug has been administered.

Group B (USG): The amount of time that passes between the initial scanning to locate the plexus, the placement of the injection needle, and the subsequent extraction of the injection needle after the medicine has been administered.

***Onset of sensory blockade*:**

Interval beginning with the time of the drug's administration and ending with the patient's loss of feeling too cold at the surgical site

***Grading of sensory blockade*:**

I= No difference

II= Some difference but cold still sensed in blocked arm

III= No cold sensation in blocked arm

***Onset of motor blockade*:**

The amount of time that passes between each injection of the medicine and the subsequent development of motor weakness in the affected limb.

Grading of motor blockade: Bromage 3-point score

0-normal motor function with full extension and flexion of elbow, wrist, and fingers.

1-decreased motor strength with ability to move only finger.

2-complete motor block with inability to move elbow, wrist and fingers.

Acta Biomed 2024; Vol. 95, N. 1: ISSN: 0392-4203 | eISSN: 2531-6745

Failure of block was defined as inadequate or patchy analgesia even after 20 mins of the drug administration. Depending on the effectiveness of the block the patient was being administered sedative & analgesic in the form of IV midazolam & Inj. Fentanyl. In case of complete failure general anesthesia was administered and the case was not included in the study. When the procedure is completed without the need of supplementation/ analgesia."

Outcome

Anaesthetic failure was treated with additional analgesics or general anaesthesia, depending on the circumstances, and a record of it was kept. The extent of the block was assessed after every five minutes for the first twenty minutes. Assessment is performed, as well as noting the entire length of sensory and motor blockade, and complete recovery from sensory and motor blockade are both blocked are noted. Patients were monitored for a whole day.

Statistical analysis

"Descriptive statistics were reported as mean (SD) for continuous variables, frequencies (percentages) for categorical variables. Chi-Square at 5% level of significance was used to find statistical significance. Fisher's exact test was used when expected cell count is less than 5. t test was also used to find the difference between the two groups for numerical data. Data was statistically evaluated with IBM SPSS statistics for window, version 25.0., IBM Corp., Chicago, IL."

Results

Mean age of the study participants among USG+PNS was 34.27±11.86 years and among USG guided alone was 35.97±11.74 years. Both the groups were similar in age distribution (p=0.5)

Mean weight of the study participants among USG+PNS was 68.23±8.78 kgs and among USG alone was 68.0±7.32 kgs. Both the groups were similar in weight distribution (p=0.98). Mean height of the study participants among USG+PNS was 168.53±8.74 cms and among USG guided alone was 162.00 cms. Both the groups were similar in height distribution (p=0.003) Gender distribution in group A 73.30% are male and 26.70% are female, and in group B 60% are male and 40% are female. There is male preponderance among both the groups. Distribution of ASA I is around 86.7% among USG+PNS guided group and 76.7% among USG guided group. Distribution of ASA II was around 13.3% among USG+PNS guided group and 23.3% among USG guided group which is not significant (p=0.51). Table 1 shows the demographic distribution of study variables.

Table 1: Distribution of Study variables among the study participants (N=60)

S.no	Variable	Group A	Group B	t/ X^2 (Df)	p
1	Age	34.27±11.86	35.97±11.74	-0.558	0.58
2	Weight	68.23±8.78	68.0±7.32	0.016	0.98
3	Height	168.53±8.74	162.00	3.05	0.003

4	**Gender** Male Female	 22 (73.3) 8 (26.7)	 18 (60) 12 (4)	1.200 (1)	0.41
5	**ASA** I II	 26 (86.7) 4 (13.3)	 23 (76.7) 7 (23.3)	1.002 (1)	0.51

Mean systolic blood pressure of the study participants among USG+PNS guided group was 132.37±10.83 mm of Hg and among USG guided group was 125.87±15.49 mm of Hg. The difference in these values was not significant (p=0.06). Mean diastolic blood pressure of the study participants among USG+PNS guided group was 83.33±9.55 mm of Hg and among USG guided group alone was 77.23±8.61 mm of Hg. Mean heart rate USG+PNS guided group was 90.40±10.38 per minute and among USG guided group was 84.37±11.17 per minute. Mean respiratory rate per minute in USG+PNS guided groupis18.47±1.25 per minute and among USG guided alone18.20±2.10 per minute. Table 2 shows the hemodynamic parameters of the study participants.

Table 2: Distribution of hemodynamic parameters among the study participants (N=60)

Slno	Hemodynamic parameters	Group A	Group B	t	p
1	Systolic blood pressure	132.37±10.83	125.87±15.49	1.883	0.06
2	Diastolic blood pressure	83.33±9.55	77.23±8.61	2.598	0.01
3	Heart Rate	90.40±10.38	84.37±11.17	2.116	0.03
4	Respiratory rate	18.47±1.25	18.20±2.10	-0.596	0.55
5	SpO2 (%)	98.60±1.27	98.83±1.17	-0.736	0.46

Mean block performance time among USG+PNS guided group is 18.94±3.47minutes and among USG guided alone group is 8.73±2.14 minutes. Mean total duration of block among USG+PNS is 392.86 ± 31.48 minutes and among USG guided alone is 325.88 ± 56.64 minutes. There is significant difference (p <0.001) in total duration of block between two groups. Table 3 shows the distribution of study outcome parameters among the study participants.

Table 3: Distribution of study outcome parameters among the study participants (N=60)

Slno	Study outcome parameters	Group A	Group B	t	p
1	Block performance time	18.94±3.47	8.73±2.14	-13.68	<0.001
2	Total duration of block	392.86±31.48	325.88±56.64	5.42	<0.001

Figure 1 shows the distribution of onset of sensory blockade. At 5 min 80% had sensory blockade among USG PNS group and 56.7% among USG group. At 10 min 96.7% had sensory blockade among USG PNS group and 83.3% among USG group. At 15 min 96.7% had sensory blockade among USG PNS group and 86.7% among USG group. At 20 min 96.7% had sensory blockade

Acta Biomed 2024; Vol. 95, N. 1: ISSN: 0392-4203 | eISSN: 2531-6745

among USG PNS group and 86.7% among USG Group. There was no significant difference in onset of sensory blockade between the groups.

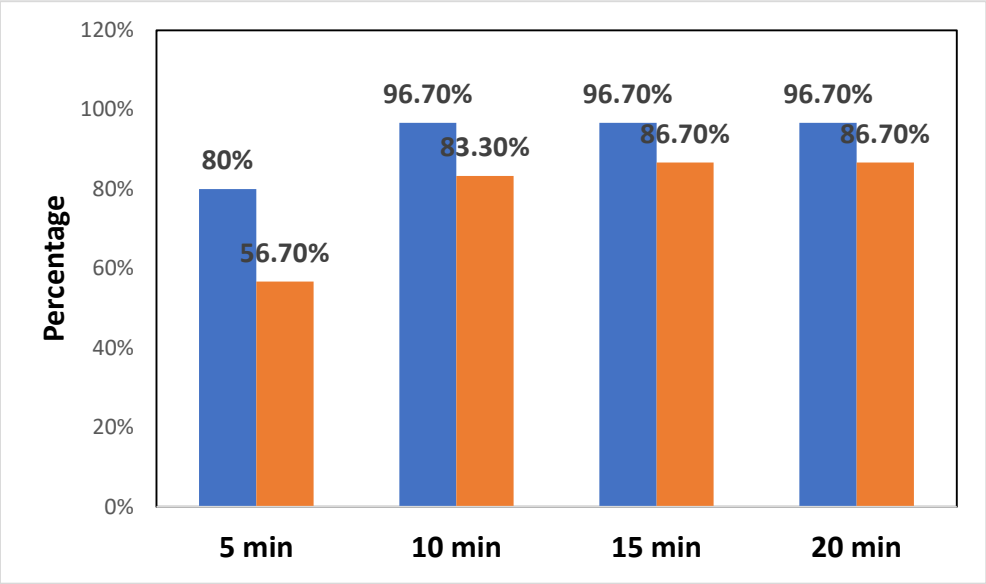

Figure 1: Onset of sensory blockade distribution

Figure 2 shows the distribution of onset of motor blockade. At 5 min 76.7% had motor blockade among USG+ PNS group and 6.7% among USG group. At 10 min 93.3% had motor blockade among USG +PNS group and 20% among USG group. At 15 min 96.7% had motor blockade among USG +PNS group and 73.3% among USG group. At 20 min 96.7% had motor blockade among USG+PNS group and 86.7% among USG Group. There is significant difference in onset of motor blockade in first 10 minutes between the groups.

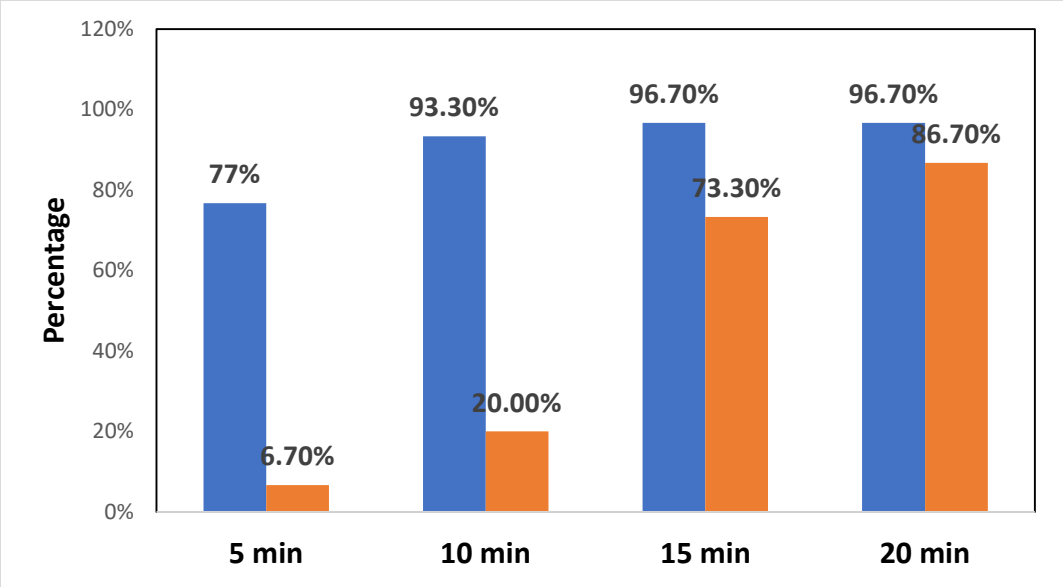

Figure 2: Onset of motor blockade distribution

Figure 3 shows the patchy block or failure is around 3.3% among USG+PNS guidance group and 13.3 % among USG guidance alone group.

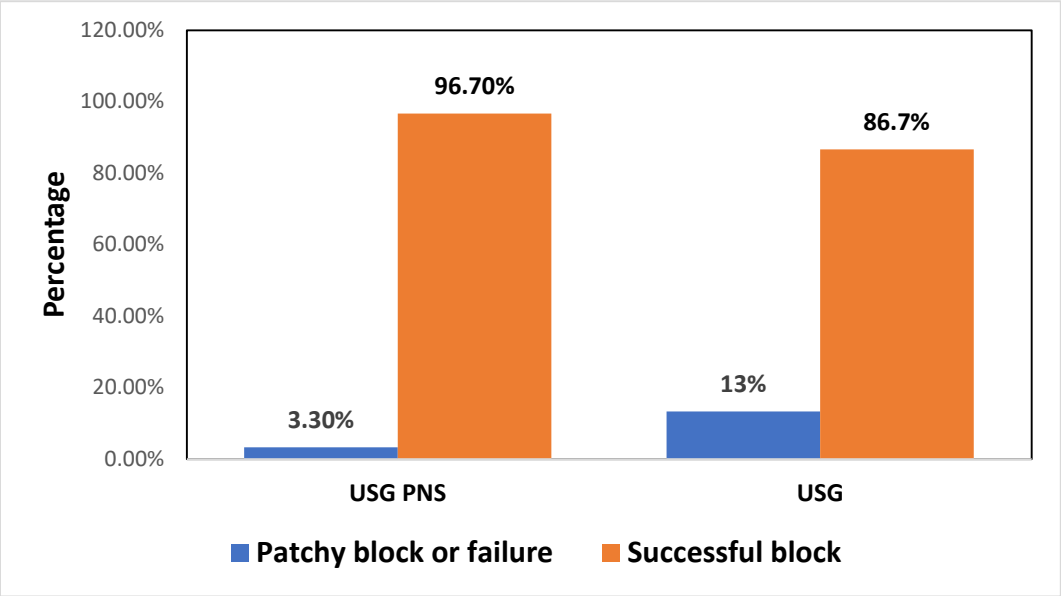

Figure 3: Patchy block or failure distribution

Discussion

The purpose of the current study was to evaluate the efficacy of using ultrasound in conjunction with neurostimulation in comparison to using ultrasound guidance alone for brachial plexus block in upper limb surgery. The primary objectives of the study were the amount of time required for the procedure and the onset of sensory and motor blockade, as well as the incidence of patchy block or failure and the total duration of blockade that was achieved. Following a random selection process, there were a total of sixty patients ranging in age from eighteen to sixty years old who participated in the study. In terms of age, weight, height, ASA class, gender, and other critical factors, both groups had statistically comparable demographics to one another.

An insulated needle that is connected to the peripheral nerve stimulator (PNS) is inserted through the skin wheal in the posterior, medial, and caudal directions after the USG has been combined with a neurostimulator. PNS is configured to send out a pulse with a current of 1.5 current, at a frequency of 1Hz, and a duration of 0.1ms. Following the observation of finger flexion in response to stimulation, the current is decreased to 0.2 mA and held there until the presence of a muscle twitch in response to 0.6 mA is noted, but there is no twitch in response to 0.2 mA current. This guarantees that the tip of the needle will be in close proximity to the nerve, and after performing a negative aspiration of air or blood, real-time visualisation can be observed. According to what is reported in the published research, when we combined neuro stimulation with ultrasound, it may be effective in the placement of deep end blocks or troublesome blocks in situations where ultrasonography views are difficult. The ability to differentiate between hyperechoic artefacts and nerve tissue (e.g., post cystic enhancement deep to axillary artery versus radial nerve). It does this

by providing functional validation of the anatomical images, which in turn improves one's understanding of peripheral nerve anatomy (e.g., obtaining and evoked motor response of each of the nerve in the axilla to demonstrate the anatomical arrangement). There is a high degree of specificity for intra neuronal tiny tip placement if the evoked motor response is less than 0.2 milliamperes (mA). When the needle vision is not at its best, this may act as a safety net for novices and trainees by preventing immediate needle nerve contact. Because of the increased accuracy of nerve placement afforded by the dual procedure, the block produced by this method is far more robust.

In our study, mean block performance time among USG+PNS group is two times more as compare to group B (18.94±3.47 vs 8.73±2., p <0.001).Onset of sensory block times is at 5 min, 10 min, 15 min, 20 min is identical in both the groups while onset time of motor blockage at 5 min is76.7% among USG+ PNS group and 6.7% among USG group, at 10 min is 93.3% among USG+ PNS group and 20% among USG group, at 15 min 96.7% among USG +PNS group and 73.3% among USG group and at 20 min 96.7% among USG+ PNS group and 86.7% among USG Group. There is significant difference in onset of motor blockade in first 10 minutes between the groups (p<0.001). Total duration of block in USG+PNS group is more as compare to USG group (392.86±31.48 vs 325.88±56.64 min., p< 0.001) this difference is statistically significant probably because of more precise location of the nerve plexus with the combined technique as compare to single technique. Number of patchy block and failure rate in USG+PNS group is less as compare to USG group (3.3% vs 13.3%, p=0.35) although this is not statistically significant. There were no complications reported in our study.

Mean block performance time

Mean block performance time among USG+PNS group is two times more as compare to group B (18.94±3.47 vs 8.73±2.14min., p <0.001). A study (Zhou et al., 2013) says that performance time was faster in US-NS group than in the US group (10.6±6.4 vs12.7±6.9 min, p = 0.05).

Onset of sensory and motor blockade

Onset of sensory block times at 5min,10min,15min,20min. is identical in both the groups while onset time of motor blockage is high with in 10 minutes in USG+PNS versus USG group (at 5minute 76.7% vs 6.7%, p<0.001 and at 10 minute, 93.3% vs 20% p<0.001). A study says that greater success rate of combined sensory-motor block within 15 minutes (79 % versus 52 %, p <0.001) (Anuradha S et al., 2020)

Total duration of block

Total duration of block in USG+PNS group is more as compare to USG group (392.86±31.48 vs 325.88±56.64min., p<0.001) this difference is statistically significant probably because of more precise location of the nerve plexus with the combined technique as compare to single technique as Singh S *et al* says that mean duration of block in US was 286.22 minutes (Singh et al., 2015).

There is considerable gape in the existing knowledge as regard of efficacy of our study. Only recently very few such studies have been done for comparison for data between combine method. However scarce literature is available regarding the same in Indian setting.

Our study comparing ultrasound guidance peripheral nerve stimulation for upper limb surgeries provides a modest improvement in block onset and quality than ultrasound guided alone. There are some limitations in this study also like the numbers of punctures/attempts were not considered as a parameter.

Conclusion

Quality and onset of the block early with ultrasound with peripheral nerve stimulator group as compare with ultrasound group. Block performance time by ultrasound with peripheral nerve stimulator group was although longer than the ultrasound guided technique group alone but justifiable. Onset of sensory was found similar in both groups. Onset of motor blockage was early in ultrasound with peripheral nerve stimulator then the ultrasound guided alone. Incidence of failed blocks are less in ultrasound with peripheral neuro stimulation as compare to ultrasound guided alone group.

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