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RESEARCH ARTICLE

COMPARISON OF PRE PROCEDURAL AND REAL TIME ULTRASOUND GUIDED SPINAL ANESTHESIA FOR TRAUMATIC LOWER LIMB INJURY

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Abstract

Objectives: The study aimed to compare real time ultrasound-guided approach with pre procedural ultrasound-guided approach for spinal anaesthesia in trauma patients.

Methods: 200 patients in two groups: group pre-procedure (PP) and group real time (RT) of 100 patients in each group using inclusion and exclusion criteria. Standard monitoring done and Spinal anesthesia was administered by a trained anesthetist. The outcome measures included the number of attempts took to access the subarachnoid space, number of skin punctures, time from first needle insertion to completion of the intrathecal injection, total procedure time, success rate of cerebrospinal fluid acquisition, failure and complications were recorded and statistical analysis was performed. A two-tailed p-value <0.05 was considered as statistically significant.

Results: Mean number of needle passes, median number of skin puncture, total time for successful lumbar puncture, the block failure rate and procedural complications were significantly less in the RT group as compared to PP group. There are widely varying reports of the failure rate of spinal anesthesia in the literature. The individual studies have reported higher success rates (97% and 100%) using real-time US guidance than with pre-procedure ultrasound (80%).

Conclusion: Real-time ultrasound-guided technique is a clinically feasible, higher success rate, less time consuming and less complication rate as compared to preprocedural ultrasound guidance technique.

Introduction:-

Bier in 1898 first described spinal anesthesia in humans [1]. The subarachnoid space can be identified with the help of anatomical landmarks and surface marking though its identification may be difficult in elderly, obese patients and polytrauma patients due to age-related degenerative changes, poorly palpable surface landmarks and difficulty in

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proper positioning[2]. There are incidences of incorrect space localization using conventional landmark-based approach as it often overlooks the anatomical variations.The accurate space identification remains a vital issue as inaccuracy may lead to multiple attempts, thereby adding to patient's discomfort, increased chances ofspinal hematoma [3], postdural puncture headache[4,5] and trauma to neural structures[6,8].Thus to attain higher chances of single puncture subarachnoid block, there is need to changethe approach.

The usage of ultrasound guidance helps in delineating spinal structures and guides the path of needle while insertion. There have continuous attempts to modify the technique in order to minimize the number of attempts.Some authors have recommended using a pre-procedure ultrasound (US) in patients with difficult spinal anatomy[9,10]. The authors have claimed that this technique can predict a difficult procedure as well as has a potential to deal with those as well [9,12] .

Real-time US guidance cansuggest the furtheradvantage in view of any patient positionalchanges in addition to trajectory guidanceduring needle insertion. In spite of these probableadvantages, information of subarachnoidblocks using real-time US guidance in patientswith predicted placement problems are limited.There is relative paucity of literature having work on trauma patients in which there is comparison of pre-procedural andrealtime ultrasound-guided spinalanaesthesia.

The current study has the hypothesis that using real time ultrasound guidance is associated with lower failure and complications ratesin comparison of using pre procedural only guidance.

Material and Methods:-

The study was conducted after approval from the Institute Ethical Committee and included 200 patients of trauma undergoing spinal anesthesia for lower limb surgery between June 2016 to May 2018after taking written and informed consent. The Consort patient flow diagram has been shown in Figure 1.

The patients were divided in two groups: group PP (pre-procedure ultrasound) and group RT (real time ultrasound) of 100 patients in each group. In Group PP patients received pre procedural USG guided spinal blockand in Group RT spinal block was given under real time USG guidance. Patients with age 18 to 65 years, ASA I-II and having ability to provide written informed consent were included in the study.Patients who refused for spinal anesthesia, INR $\geq$ 1.5, platelet count $<75 \times 10^9$/L, coagulopathy, local infection at the site of injection orallergy to local anesthetics were excluded in the study. After performing of standard monitoring (heart rate, noninvasive arterial pressure, electrocardiography, pulse oximetry) and obtaining intravenous access,spinalanesthesia was administered by a trained anesthetist.

The patient was kept in sitting position and under full aseptic technique with gloves, gown, mask, and steriletransducer cable sheath, ahigh frequency (2–5 MHz) curvilineartransducer attached to an ultrasound machine was kept on the back of patient in para midline position applied to the patient'sback.

In group PP, the sacrum was identified first in parasagittal oblique view following which interlaminar space between L5 –S1 was identified for all patients. A skin marker was used to mark the long and short borders of probe. The medial angulation of probe for spinal needle insertion was also noted. The midpoint of long and short border of probe was marked for paramedian insertion. The midpoint of long border in transverse median view for medial angulation was also marked. The aseptic skin preparation was done aftermarking and 2-3 ml of 1% lidocaine was infiltrated the skin and spinal anesthesia was performed.

In Group RT, using aseptic technique L5-S1 space was identified in parasagittal. After infiltration of local anesthesia, spinal needle was inserted in plane to ultrasound probe.Interspinous spaces, ligamentum flavum-dura matercomplex and the posterior aspect of vertebral body was identified. The angle of needle was adjusted in real time and needle was gradually advanced to the interlaminar spaceuntil the tip passed through the ligamentum flavum. The 25G spinal needle (90 mm long) was chosen for both groups.Once Dural puncture wasachieved and confirmed by backflow of cerebrospinal fluid (CSF) fromthe needle hub, 0.5% hyperbaric bupivacaine 15 mg with fentanyl (5–15 μg) was injected over 15–20 s and the patient were then returned to the lateral or supine position. Injection midazolam 1-2 mg was used for intraoperativesedation, and oxygen (4 L/min) administered via facemask.The spinal anesthetic was considered to have failed if theprocedure was converted to general anesthesia within the one hour after intrathecal injection. Postoperative pain was managed with injection diclofenac.

The number of attempts required to access the subarachnoid space was noted and was considered as an outcome measure. The maximum allowed number of needle passes was 3.Number of skin punctures(maximum 5 puncture),the total timerequired for completion of the intrathecal injection,the time taken in procedure(excluding patient positioning and local anesthetic preparation), success rate of CSF acquisition, failure and complications were recorded.

Statistical Analysis:

In the current study total 200 trauma patients undergoing lower limb surgery were included and were grouped to receive either the pre-procedural or real time ultrasound guided midline spinal anesthesia. The mean (±SD) number of skin puncture was 3.18±1.20 and 1.75±1.0 respectively. Based on normal approximation method, the interpretation of power in this study would be 100% chance of detecting a difference without the continuity correction.

The formula for the estimation of power is as follows:

$$Power = \Phi\left(-Z_{1-\alpha/2} + \frac{\sqrt{n_1}\Delta}{\sqrt{\sigma_1^2 + \sigma_2^2/\kappa}} \right)$$

The notation for the formulae is:

n_1 = sample size of Group 1

σ_1 = standard deviation of Group 1

σ_2 = standard deviation of Group 2

Δ = difference of group means

κ = ratio of sample size: Group 2/ Group 1

$Z_{1-\alpha/2}$ = the two-sided Z value (e.g. Z=1.96 for 95% confidence interval).

Statistical analysis was performed using SPSS version 23.0 (IBM Corporation, NY, and USA). Categorical data were compared using Chi-square test. Normally distributed data were summarized as mean ± SD and were compared between groups using the independent Student t test. Non-normally distributed data were summarized as mean (Interquartile range – IQR) and were compared using Mann-Whitney U test. A two-tailed p-value <0.05 was considered as statistically significant.

Results:-

A total 200 patients were met inclusion criteria and 100 were randomized to each group i.e. group PP and group RT. No dropouts were noted and no patients were lost for follow up (Figure 1). The distribution of demographic data such as age, sex, weight, height and body mass index (BMI) was comparable between the groups (Table 1).

The mean number of needle passes was 2.19±0.76 in the group PP and 1.41±0.66 in the RT group. The mean number of needle passes were less in the RT group as compared to PP group which was statistically significant (p<0.001) (Table 2). The median number of skin puncture was 3 (IQR 3-4) in group PP and 1 (IQR 1-3) in the RT group. The median number of skin puncture was less in RT group as compared to PP group which was statistically significant (p<0.001) (Table 2). The time taken in the procedure starting from first needle insertion to completion of the intrathecal injection was comparable between the groups (p=0.965) (Table 2).The total time for successful lumbar puncture was significantly more in PP group (11.21±3.41 min) as compared to group RT (9.36±3.41 min) (p<0.001) (Table 2).

In group RT, 92% patients had successful CSF acquisition, whereas in group PP 66% patients had successful CSF acquisition at the end the procedure (p<0.001). In RT group, the block failure rate was 8%, whereas in group PP 34% block failure rate (p<0.001). In PP group, procedural complications were noted in 14% cases which was significantly higher in RT group (2%) (p<0.001) (Table 3).

Discussion:-

Real-time US guidance may provide the further advantage of considering any patient positional changes in addition to trajectory guidance during needle placing. But the role of real-time US-guidance for neuraxial anesthesia is still not well defined.

Earlierreports have explored the advantages of pre-proceduralultrasound-guided neuraxial blockade. However, because of differentpopulations and patient characteristics, results were conflicting [9,11,13,14].

In the present study, with the real-time US guidance technique for spinal anesthesia in trauma patients, we found that the number of needle passes and number of skin puncture were less compared with the pre-procedural ultrasound-guided paramedian technique. In addition, it also saved significant time and patient discomfort from repeated needle redirection attempts. But time from first needle insertion to completion of the intrathecal injection was comparable in both the groups.

In our study, the demographic characteristic of patients was comparable in both the groups. The mean number of needle passes was 2.19±0.76 in the group PP and 1.41±0.66 in the RT group. The mean number of needle passes were less in the RT group as compared with PP group which was statistically significant ($p<0.001$). The median number of skin puncture was 3 (IQR 3-4) in group PP and 1 (IQR 1-3) in the RT group. The median number of skin puncture was less in RT group as compared to PP group which was statistically significant ($p<0.001$).

In this study, the total procedure time in RT group was 9.36±2.11 min and PP group was 11.21±3.41 min this showed the RT group had take significantly less procedure time than PP group ($p<0.001$).In a study by Conroy et al[15] found in his study the total time taken for real-time US guided procedure was8 ± 4.68 minutes which was similar to our study in RT group. Study in pre-procedural ultrasound-guided paramedian technique by Wang et al[16] discovered the mean duration for the total CSE procedure in obese parturient to be 9.37±1.35 minutes. Another study by Chin et al[9] found the mean total procedure time was 12.2±6.0 when pre-procedural ultrasound was utilized for spinal anesthesia in orthopedic patients with difficult surface anatomic landmarks. These findings also showed the superiority of real-time US guidance paramedian technique.

In our study a success rate of 92% in CSF acquisition using real-time US guidance had significantly more as compared with 66% in preprocedural ultrasound guidance technique. In a study by Conroy et al[15] and Elsharkawy et al [17] found a success rate of 97% and 100% in CSF acquisition using real-time US guidance.In an RCT investigating patients with normal surface anatomic landmarks undergoing spinal anesthesia, Abdelhamid et al [18] found a first attempt success rate of 80% in the pre-procedure ultrasound group. These findings proved that real-time US guidance is superior to pre-procedural ultrasound-guided paramedian technique.

Failure of spinal anesthesia has been defined as the need to convert to general anesthesia or to repeat the intrathecal injection following the initial block. In our study, RT group had less failure rate (8%vs. 34%) and fewer complications (2%vs. 14%) which were statistically significant.The available literature reports the failure rate of spinal anesthesia ranging from <1% to 17% [19].

Conclusion:-

Our study is a single centre comparative observational study but no study is available in the literature to compare pre-procedural ultrasound and real-time US guided paramedian technique in lower limb surgery. We cannot, therefore, make any direct comparisons between this approach versus a pre-puncture ultrasound or landmark only technique. But our results demonstrated that real-time ultrasound-guided technique is a clinically feasible, higher success rate, less time consuming and less complication rate as compared to preprocedural ultrasound guided technique.

Glossary of Abbreviations/Acronyms used

1. Cerebrospinal Fluid- CSF
2. Ultrasound- US
3. Pre-procedural- PP
4. Real Time- RT
5. Parasagittal oblique- PSO

6. American Society of Anesthesiologists ASA
7. International Normalized Ration – INR
8. MHz- Mega Hertz
9. cm- centimeter
10. Lumbar- L
11. ml- milliliters
12. G- Gaze
13. μg- Microgram
14. Mg- Milligram
15. L/min- Liters per minute
16. SD Standard Deviation
17. Body mass index- BMI
18. Interquartile range – IQR
19. Kg- Kilogram
20. Kg/m^2 – kilogram per meter square

Table 1:- Demographic characteristics of the patients in the two groups Pre procedural (PP) and real time (RT).

	PP Group (n=100)	**RT Group (n=100)**	**p-value**
Age, years (mean±SD)	36.82±10.301	37.03±9.530	0.881
Sex (Male/Female)	83/17	80/20	0.584
Height (cm)	152.34±4.55	151.87±6.36	0.548
Weight (kg)	50.35±8.45	49.27±6.22	0.304
BMI, kg/m^2 (mean±SD)	22.520±3.1956	22.796±2.4156	0.492

BMI: Body Mass Index; SD: Standard Deviation

Table 2:- Procedural Details like number of needle passes, skin punctures and time taken in the two groups Preprocedural (PP) and real time (RT).

	PP Group (n=100)	**RT Group (n=100)**	**p-value**
No. of needle passes (mean ± SD)	2.19±0.76	1.41±0.66	<0.001
No. of skin puncture (median, IQR)	3 (3-4)	1 (1-3)	<0.001
Time from first needle insertion to completion of the intrathecal injection (Mean±SD)	2.465±0.739	2.470±0.85	0.965
Total time (Mean±SD)	11.21±3.41	9.36±2.11	<0.001

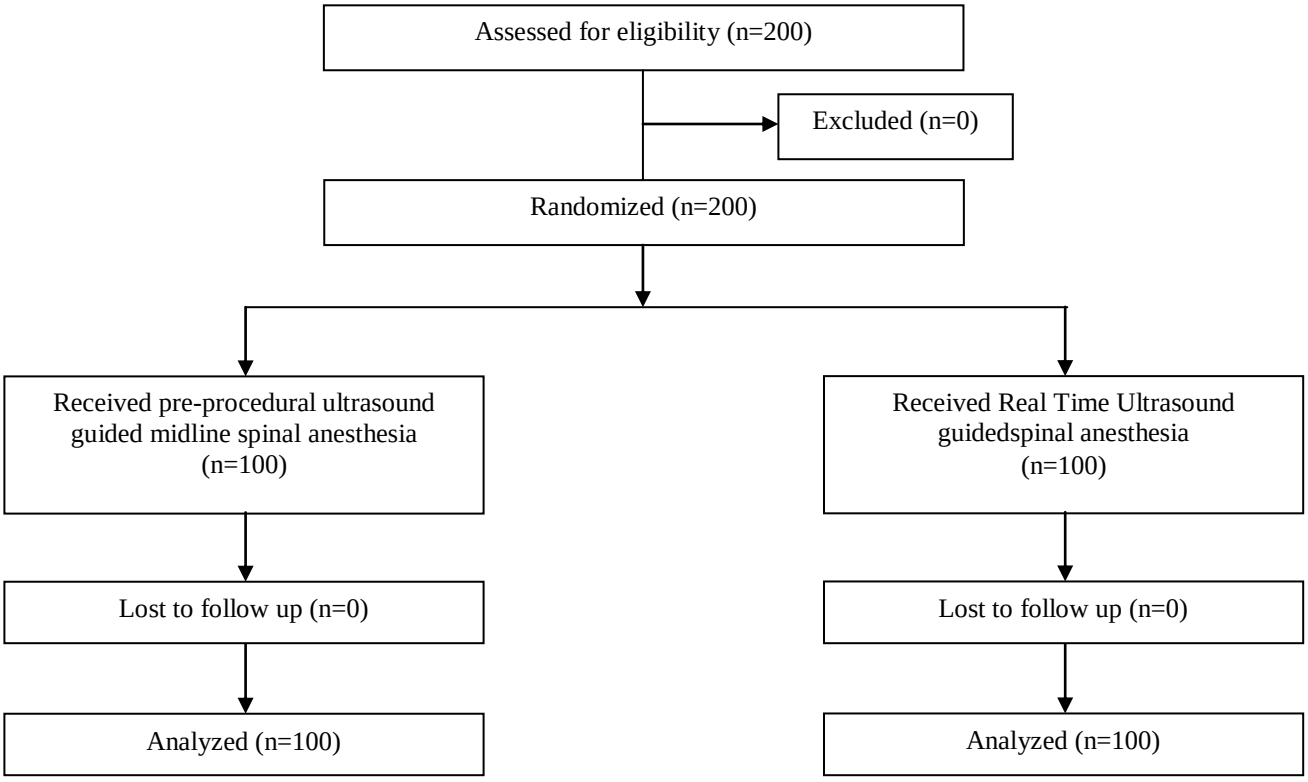
IQR: Inter Quartile Range

Table 3:- Outcome of the procedure like CSF acquisition, failure and complications in the two groups Preprocedural (PP) and real time (RT).

	PP Group (n=100)	**RT Group (n=100)**	**p-value**
CSF acquisition	66 (66%)	92 (92%)	<0.001
Failure	34 (34%)	8 (8.0%)	<0.001
Complication	14 (14%)	2 (2.0%)	<0.001

CSF: Cerebrospinal Fluid

Figure 1:- Patient enrollment flow diagram.



References:-

1. Bier A. Versuche über cocainisirung des rückenmarkes. Deutsch Zeitschrift für Chirurgie. 1899;51(3):352–358.
2. Broadbent CR, Maxwell WB, Ferrie R, Wilson DJ, Gawne-Cain M, Russell R. Ability of anaesthetists to identify a marked lumbar interspace. Anaesthesia. 2000;55(11):1122–1126. PMID: 11069342DOI: 10.1046/j.1365-2044.2000.01547-4.x
3. Wulf H. Epidural anesthesia and spinal haematoma. Canadian Journal of Anaesthesia. 1996;43(12):1260–1271. PMID: 8955979DOI: 10.1007/BF03013437
4. Flaatten H, Felthaus J, Larsen R, Bernhardsen S, Klausen H. Postural post-Dural puncture headache after spinal and epidural anesthesia. A randomised, double-blind study. Acta Anaesthesiologica Scandinavica. 1998;42(7):759–764. PMID: 9698949DOI: 10.1111/j.1399-6576.1998.tb05318.x
5. Harrison DA, Langham BT. Spinal anesthesia for urological surgery. A survey of failure rate, postdural puncture headache and patient satisfaction. Anaesthesia. 1992;47(10):902–903. PMID: 1443490DOI: 10.1111/j.1365-2044.1992.tb03161.x
6. Auroy Y, Narchi P, Messiah A, Litt L, Rouvier B, Samii K. Serious complications related to regional anesthesia: Results of a prospective survey in France. Anesthesiology. 1997;87(3):479–486. PMID: 9316950DOI: 10.1097/00000542-199709000-00005
7. Puolakka R, Haasio J, Pitkänen MT, Kallio M, Rosenberg PH. Technical aspects and postoperative sequelae of spinal and epidural anesthesia: a prospective study of 3,230 orthopedic patients. Regional Anesthesia and Pain Medicine. 2000;25(5):488–497. PMID: 11009234DOI: 10.1053/rapm.2000.7607
8. Horlocker TT, McGregor DG, Matsushige DK, Schroeder DR, Besse JA. A retrospective review of 4767 consecutive spinal anesthetics: central nervous system complications. Anesthesia and Analgesia. 1997;84(3):578–584. PMID: 9052305DOI: 10.1097/00000539-199703000-00021
9. Chin KJ, Perlas A, Chan V, Brown-Shreves D, Koshkin A, Vaishnav V. Ultrasound imaging facilitates spinal anesthesia in adults with difficult surface anatomic landmarks. Anesthesiology 2011;115:94-101.PMID: 21572316DOI: 10.1097/ALN.0b013e31821a8ad4

10. Willschke H, Bosenberg A, Marhofer P, Willschke J, Schwindt J, Weintraud M, et al. Epidural catheter placement in neonates: Sonoanatomy and feasibility of ultrasonographic guidance in term and preterm neonates. Reg Anesth Pain Med 2007;32:34-40.PMID: 17196490DOI: 10.1016/j.rapm.2006.10.008
11. Kallidaikurichi Srinivasan K, Iohom G, Loughnane F, Lee PJ. Conventional Landmark-Guided Midline Versus Preprocedure Ultrasound-Guided Paramedian Techniques in Spinal Anesthesia. Anesth Analg 2015;121:1089-96.PMID: 26270115DOI: 10.1213/ANE.0000000000000911
12. Chin KJ, Ramlogan R, Arzola C, Singh M, Chan V. The utility of ultrasound imaging in predicting ease of performance of spinal anesthesia in an orthopedic patient population. Reg Anesth Pain Med 2013;38:34-8.PMID: 23143015DOI: 10.1097/AAP.0b013e3182734927
13. Ansari T, Yousef A, El Gamassy A, Fayez M.Ultrasound-guided spinal anesthesia in obstetrics: is there an advantage over the landmark technique in patients with easily palpable spines? Int J Obstet Anesth 2014;23: 213-216.PMID: 24768303DOI: 10.1016/j.ijoa.2014.03.001
14. Arzola C, Mikhael R, Margarido C, Carvalho JC. Spinal ultrasound versus palpation for epidural catheter insertion in labour: A randomized controlled trial. Eur J Anaesthesiol 2015; 32: 499-505.PMID: 25036283DOI: 10.1097/EJA.0000000000000119
15. Conroy PH, Luyet C, McCartney CJ, McHardy PG. Real-Time Ultrasound-Guided Spinal Anaesthesia: A Prospective Observational Study of a New Approach. Anesthesiology Research and Practice 2013; 2013:1-7.PMID: 23365568PMCID: PMC3556419DOI: 10.1155/2013/525818
16. Wang Q, Yin C, Wang T. Ultrasound facilitates identification of combined spinal-epidural puncture in obese parturient. Chin Med J (Engl). 2012;125(21):3840-3843.PMID: 23106885
17. Elsharkawy H, Maheshwari A, Babazade R, Perlas A, Zaky S, et al. Real-time ultrasound-guided spinal anesthesia in patients with predicted difficult anatomy. Minerva Anestesiol 2017;83: 465-473.PMID: 28094482DOI: 10.23736/S0375-9393.16.11610-4
18. Abdelhamid SA, Mansour MA. Ultrasound-guided intrathecal anesthesia: Does scanning help? Egyptian Journal of Anaesthesia. 2013;29(4):389-394. DOI: 10.1016/j.egja.2013.06.003
19. Fettes PDW, Jansson JR, Wildsmith JAW. Failed spinal anesthesia: mechanisms, management, and prevention. British Journal of Anaesthesia 2009;102(6):739–748.https://doi.org/10.1093/bja/aep096.