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Comparison of the Effects of using three Different Types of Needles on Sub Arachnoid Block: A Clinical Study

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Abstract

Background: Anaesthesia alleviates human sufferings during the surgical procedures. It may be either General anaesthesia or Regional anaesthesia depending upon surgery. General anaesthesia imparts total sensory loss. It also entails poly pharmacy, that is, use of multiple drugs for achieving "Balanced Anaesthesia". But then, loss of consciousness requires maintenance of airway, even an artificial airway like endotracheal intubation. Use of multiple drugs have their inherent side effects. Hence, general anaesthesia is always stratified in respect to its risk-benefit in individual case scenario. *Materials & Methods:* The present study was undertaken at Pushpagiri institute of medical sciences Thirunalla Patients posted for sub-umbilical surgeries under intra dural anaesthesia were included in the study. Among 150, Patients were randomly divided into three groups, each group containing 50. Group I (Q) - Patients who received SAB with Quincke 27G needle n=50. Group II (S) - Patients who received SAB with Sprotte 27G needle n=50. Group III (W) - Patients who received SAB with Whitacre 27G needle n=50. Descriptive statistical analysis has been carried out in the present study. *Results:* There is no statistically significant difference in body height and age group among the study groups $p>0.05$. This indicates that there is no statistical difference in the inter space selected for lumbar puncture $p=0.22$. This implies that, there is no statistically significant difference for the number of attempts taken to perform Lumber puncture. $p=0.92$.This signifies that, there is no statistical difference with respect to Bromage scale among the study groups. $p>0.05$. *Conclusion:* Thus, pencil point Whitacre needle is better choice in view of early onset, more height achieved, low incidence of PDPH and less failure rates. However, cost factor should be weighed against the complication.

Keywords: Intra Dural Anaesthesia; 27G Whitacre; 27G Quincke; 27G Sprotte.

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Introduction

Intra Dural Anaesthesia (sub arachnoid block) is a type of Regional Anaesthesia involving the injection of a local anaesthetic into the subarachnoid space through a needle. It is commonly used for sub umbilical procedures. Even today it is a preferred technique due to various advantages over General Anaesthesia like patient being conscious and natural airway maintained [1,2].

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Epidural anaesthesia could also be used for sub umbilical procedures. But, because of the known technical challenges of readily identifying the epidural space along with dreadful complication of total spinal anaesthesia and the toxicity associated with the large doses of local anaesthetics needed for epidural anaesthesia, spinal anaesthesia was the dominant form of neuraxial anaesthesia in the 20th century. Moreover as opposed to epidural anaesthesia intradural anaesthesia produces intense sensory and motor blockade. As the abdominal muscles are intensely blocked it comparatively gives ideal operating conditions the operating surgeon in most sub-umbilical surgical procedures.

However, alternatively, spinal and epidural anaesthesia can be used jointly, taking advantage of the qualities of both techniques by means of combined spinal epidural technique.

Intra Dural anaesthesia has stood the test of time due to its ease of use. However, there is constant updating of its techniques. It is a safe and effective alternative to General anaesthesia especially in sub umbilical surgeries.

Additional benefits of Intra Dural anaesthesia may include:

- reducing the metabolic stress response to surgery,
- reduction in blood loss,
- decrease in the incidence of venous thromboembolism,
- reduction in pulmonary compromises, particularly in patients with advanced,
- pulmonary disease,
- The ability to monitor the patient's mental status,
- The technique is cost effective,

For surgeons, spinal anaesthesia provides intense blocking of abdominal muscles, which leads to intense muscle relaxation. This provides ideal operating conditions in most sub-umbilical procedures. There is also lesser blood loss due to inherent controlled hypotension as a result of sympathetic blockade during intrathecal anaesthesia.

But, Intra Dural anaesthesia is often followed by Post Dural Puncture Headache. This is a distressing complication of intra dural anaesthesia. This is due to leakage of CSF into epidural space. Puncture of the dura has the potential to allow the development of excessive leakage of CSF. Excess loss of CSF leads to intracranial hypotension and a demonstrable reduction in CSF volume [3]. The leakage of CSF is likely attributableto the magnitude of puncture or opening created in the duramater which, in turn, depends on the size or Gauge of the spinal needle used. The larger the Gauge or size of the needle the more is the magnitude of puncture or opening created in the duramater leading to more CSF leakage and vice versa. However, the reintroduction of side port atraumatic needle can affect the distribution of local anaesthetic agent. Besides, the flow patterns of fluid injected through these needles have different properties when compared with conventional Quincke needle.

Aims and Objective of the Study

The study is designed to evaluate the following effects of using two different pencil Point needles (Whitacre, Sprotte) and one conventional cutting (Quincke) needle in patients undergoing lower abdominal surgical and gynaecological procedures.

1. Effect on onset of block.
2. Effect on height of block.
3. Effect on regression of block.
4. To reduce the incidence of P.D.P.H.
5. Incidence of back ache and N.P.D.P.H.
6. Incidence of failure rate.
7. To assess the difficulty of the procedure.
8. Patient acceptability.

Materials & Methods

Study Population

The present study was undertaken at *Pushpagiri institute of medical sciences Thirunalla* Patients posted for sub-umbilical surgeries under intra duralanaesthesia were included in the study.

Sample Size: 150 Patients.

Sample Design: Among 150, Patients were randomly divided into three groups, each group containing 50.

Inclusion Creteria

- Patients' age less than 60 years.
- Patients' height between 155-168 cm.
- Patients belonging to ASA Grade I and II.

Exclusion Creteria

- Patients with history of chronic headache.

- Patients with history of migraine.
- Patients with history of backache.
- Patients of ASA Grade III and above.
- Any contraindication to intra dural anaesthesia.

Study Design

After Institutional ethical committee approval was obtained, it was proposed to carry out a randomised controlled study of patients posted for sub-umbilical procedure under intra dural anaesthesia.

Informed written consent was obtained from each patient included in the study after explaining in detail about the study undertaken.

Pre-Anaesthetic Checkup

Standard pre-anaesthetic check-up protocol of the institution was followed.

A detailed history was recorded.

- Present and past medical illness.
- past h/o of anaesthetic exposure.
- Concomitant history of drug allergy and.
- Any medications in preoperative period were recorded.

General physical examination, systemic examination and airway examination of all the patients were done.

- Height in cm and weight in kg were recorded.
- Routine investigation and relevant specific investigations were ordered.

Pre-anaesthetic advice

1. Nil Per Oral, at least for six hours, previous night of proposed surgery day,
2. Tablet Ranitidine 150 mg HS.
3. Tablet Metoclopramide 10 mg HS.

During pre-anaesthetic check-up patients were explained and made familiar with methodology for ascertaining sensation and motor power to be used in the study.

Methods

On the day of surgery:

Patients were randomly allocated into 3 groups.

- ✓ Group I (Q) - Patients who received SAB with Quincke 27G needle n=50.
- ✓ Group II (S) - Patients who received SAB with Sprotte 27G needle n=50.
- ✓ Group III (W) - Patients who received SAB with Whitacre 27G needle n=50.

On arrival to OT, in pre-anaesthetic room, after verifying informed written consent and confirming NPO status, a wide bore IV line was established at the ventral aspect of forearm. A preload of 10 ml/kg of ringer lactate solution was administered before SAB.

In the operating room, the following monitors were attached-NIBP, ECG and pulse oximeter. All basal line readings of the monitor were recorded.

Onset of action was assessed by checking the sensory block achieved at 5 min by Pinprick method bilaterally. Maximum height achieved was considered as the height of theblock.

The patients, on whom sensory block was not satisfactory for the surgical procedure, were pronounced as failed spinal anaesthesia; and were managed with conversion to general anaesthesia.

Statistics

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients, Chi-square/2x3, 3x4 Fisher Exact test has been used to find the significance of study parameters on categorical scale between two groups. ANOVA has been used to test the homogeneity samples based on of age (or continuous parameters) and Chi-square test to test the homogeneity of samples based on parameters on categorical scale between two groups.

Results

Study design: A prospective, controlled and comparative study with 150 patients randomized in to three groups with,

- 50 in Group I(Q) - Quincke Needle 27 Gauge,
- 50 patients Group II(S)- Sprotte 27 Guage Needle and
- 50 patients in Group III (W)-Whitacre 27 Gauge Needle

Demographic Characteristics

There is no statistically significant difference in body height and age group among the study groups. p > 0.05 (Table 1).

This indicates that there is no statistical difference in the inter space selected for lumbar puncture p=0.22 (Table 2).

This implies that, there is no statistically significant difference for the number of attempts taken to perform Lumber puncture. p=0.92 (Table 3).

This signifies that, there is no statistical difference with respect to Bromage scale among the study groups. p > 0.05 (Table 4).

Out of 9 patients who had experienced PDPH, the headache was localised to frontal region in 4 (8.0%) patients of group Q and 1 (2%) patient of group S and W (Table 5).

In group Q, 3 patients reported that the headache was localised to occipital region also. But, none of patients of group S and W reported the same.

None of the patients of any group reported the symptom of generalised headache.

So far, statistically there is no significant difference among the study groups. p=0.64.

Table 1: Age, weight and Height distribution of patients

Demographic Variables	Group Q	Group S	Group W	p value
Age in years	36.73 ± 9.18	36.80 ± 9.57	37.72 ± 5.55	0.56
Weight in Kg	55.11 ± 6.05	55.35 ± 5.41	55.01 ± 5.29	0.98
Height in cm	157.34 ± 5.49	158.86 ± 5.26	158.41 ± 5.51	0.76

Table 2: Interspace selection of patients

Interspace	Group Q		Group S		Group W		All Patients	
	No.	%	No.	%	No.	%	No.	%
L3-4	40	80.0	46	92.0	43	86.0	129	86.0
L4-5	10	20.0	4	8.0	7	14.0	21	42.0
Total	50	100.0	50	100.0	50	100.0	150	100.0

Table 3: Number of attempts

Number of attempts	Group Q		Group S		Group W	
	No.	%	No.	%	No.	%
1	37	74.0	34	68.0	33	66.0
2	9	18.0	11	22.0	11	22.0
3	4	8.0	5	10.0	6	12.0
Total	50	100.0	50	100.0	50	100.0

Table 4: Comparison of regression of the block assessed by the Bromage scale

Bromage score	Group Q	Group S	Group W	Significance
Grade 4	185.30 ± 17.80	184.19 ± 18.06	184.50 ± 11.94	p=0.998
Grade 3	155.30 ± 17.80	154.19 ± 18.06	154.50 ± 11.88	p=0.997
Grade 2	125.30 ± 17.80	124.29 ± 18.06	124.50 ± 11.88	p=0.997
Grade 1	101.50 ± 16.50	100.11 ± 17.28	96.04 ± 15.86	p=0.922

Table 5: Location of PDPH

Location of PDPH	Group Q (n=50)	Group S (n=50)	Group W (n=50)
Frontal	4 (8.0%)	1 (2.0%)	1 (2%)
Occipital	3 (6%)	0	0
Generalized	0	0	0

Out of 9 patients who had developed PDPH, all of them reported the symptoms of Grade I severity, that is 7 patients of group Q (14%), 1 patient (2%) of group S and W. None of them reported either Grade II or Grade III severity (Table 6).

Out of 9 patients who had developed PDPH, the signs and symptoms of PDPH subsided within 24 hours of time. In none of the patients, the duration of PDPH progressed to more than 24 hours (Table 7).

This infers, there is no statistically significant difference among the groups. p=1.0.

Among 7 patients of group Q, who had experienced PDPH, 5 (72%) patients received treatment for the same and 2 (28%) patients did not receive treatment. In group S and W, one patient of each group had developed PDPH and each patient received treatment for the same (Table 8).

This suggests that, there is statistically no significant difference among the groups with respect to treatment of PDPH. p= 0.06.

2 patients (4%) of group Q complained of backache. None of the patients of group S and W complained the same (Table 9).

NPDPH was seen among 3 patients (6%) of group Q, and 2 patients (4%) of group S and group W respectively.

However, there is no statistically significant difference among the groups. p=0.35.

Acceptability by the patients is almost equal among all the study groups that is group Q 94%, group S and group W 92% (Table 10).

Moreover, it is Good in all the groups.

Nonetheless, there is no statistically significant difference among the groups. p=0.90.

Among the study groups, failure rate is more in

Table 6: Severity of PDPH

Severity of PDPH	Group Q (n=50)	Group S (n=50)	Group W (n=50)
Grade I	7 (14.0%)	1 (2.0%)	1 (2%)
Grade II	0	0	0
Grade III	0	0	0

Table 7: Duration of PDPH

Duration of PDPH	Group I (n=50)	Group II (n=50)	Group III (n=50)
<24 hours	7 (6.0%)	1 (2.0%)	1 (2.0%)
24-48 hours	0	0	0
>48 hours	0	0	0

Table 8: Treatment of PDPH

Treatment	Group Q	Group S	Group W
Yes	5 (72%)	1 (100%)	1 (100%)
No	2 (28%)	0	0

Table 9: Incidence of NPDPH and backache

Complications	Group Q (n=50)	Group S (n=50)	Group W (n=50)
Back ache	2 (4%)	0	0
NPDPH	3 (6.0%)	2 (4.0%)	2 (4.0%)

Table 10: Acceptability

Acceptability	Group Q (n=50)	Group S (n=50)	Group W (n=50)
Good	47(94.0%)	46(92.0%)	46(92.0%)
Not Good	3(6.0%)	4(8.0%)	4(8.0%)

Table 11: Failure rate

Failure	Group Q (n=50)	Group S (n=50)	Group W (n=50)
Yes	1 (2%)	5 (10.0%)	2 (4.0%)
No	49 (98%)	45 (90.0%)	48 (96.0%)

group S-10% followed by group W-4% and least in group Q-2% (Table 11).

Discussion

Demography

The demographic data of age, sex, height, weight and ASA grading are similar in all the study groups. This lead to avoidance of false positive or false negative results in the study according to the demographic variability.

Age distribution of patients

Among the age group of 20-29 years, 15 patients (30%) were in group Q, 15 in group S (30%) and 14 in group W (28%). Out of 150 patients, 42 were in this age group constituting about 29%.

Among the age group of 30-39 years, 14 patients were in group Q (28%), 13 in group S (26%) and 14 in group W (28%). Out of 150 patients, 41 were in this age group constituting about 27%.

Among the age group of 40-49 years, 15 patients were in group Q (30%), 16 in group S (32%) and 12 in group W (24%). Out of 150 patients, 43 were in this age group constituting about 28%.

Among the age group of 50-59 years, 6 patients were in group Q (12%), 6 in group S (12%) and 10 in group W (20%). out of 150 patients, 22 were in this age group constituting about 14%.

Gender distribution of patients

In group Q among 50 patients, 23 were male (46%) and 27 female (54%). Similarly, in group S, 26 male (52%), 24 female (48%) and in group W 30 male (60%) and 20 (40%) female. Out of 150, male were 79 (52.66%) and female 71 (47.33%).

Yet, there is no statistically significant difference in gender distribution between the study groups. Samples are gender matched. p=0.37.

ASA grade of patients

Out of 130 patients, 42 patients (84%) of group Q belong to ASA Gr I, 43 (86%) in group S and 45 (90%) in group W.

Out of 20 patients, 8 patient (16%) of group Q belong to ASA Gr II, 7 (14%) in group S and 5 (10%) in group W.

This denotes that, there is no statistically significant difference in ASA grade of study groups. p=0.66.

Comparison of Height of the block in three groups of patients

Out of 50 patients of group Q, height of block achieved was T10 for 7 (14%) patients, T8 for 18 (36%) and T6 for 20 (40%) and T4 for 5 (10%).

Out of 50 patients of group S, height of block achieved was at T10 for 1 (2%) patient, T8 for 5 (10%), T6 for 28 (56.0%) and T4 for 16 (32%).

Out of 50 patients of group W, height of block achieved was at T10 for 1 (2%) patient, T8 for 2 (4%), T6 for 29 (58%) and T4 for 18 (36%).

This indicates that, there is statistically significant difference for height of block achieved at T4 level among study groups. p=0.02.

Total Incidence of PDPH was 9, out of which 7 were of Group Q and 1 in each, Group S & W.

In group Q, onset of PDPH occurred on day 1 for 4 (8%) patients, on day 2 for 2 (4%) patients and on day 3 in 1 (2%) patient. None of the patients of this Group had PDPH on day 4.

Onset of PDPH was seen in 1 (2.0%) patient on day 1 of group S and W, but none of the patients experienced PDPH from day 2-day 3.

This implies, that statistically there is significant difference among the study groups for onset of PDPH on day-1 to day-3. $p<0.05$.

Number of attempts

There are many factors that affect the distribution of local anaesthetic within the intrathecal space. Factors that anaesthetist has some control over are physical characteristic of the injectate and the technique of injection.

The reintroduction of side port can affect the distribution of local anaesthetic agent. Also the flow pattern of fluid injected through the needle have different properties when compared to the conventional Quincke needle. In vitro work, Stephen HJ et al. [4] has suggested that flow patterns become turbulent from Whitacre needles at injection rate that are much faster and more clinically relevant than those obtained with Quincke needle of the same gauge.

In the present study, onset of sensory block at 5 min was assessed. It is earlier in group II (Sprotte Needle) and Group III (Whitacre needle) than with Quincke needle.

T8 level achieved	T6 level achieved
Group Q – 20%	Group Q – 0%
Group S – 66%	Group S – 14%
Group W – 68%	Group W – 20%

p value 0.001 is statistically significant.

The present study is comparable to study done by L Anderson et al. In their study, slow injection at a rate of 1 ml/min of 0.5% plain Bupivacaine with orifice pointing cephalad produced initial greater spread. This resulted in more rapid onset of sensory block with Whitacre needle. In an in vitro model of slow injection was shown to produce a greater spread of local anaesthetic than a faster turbulent flow. With the slow injection, injectate tends to adhere to and travel further along any surface it contacted in its original direction before the momentum ran out. Local anaesthetic remained concentrated in posterior compartment of CSF where the sensory nerve roots are present. Conversely the fast injection produced a turbulent pattern that whirled back from the surface, causing the distribution to be less directional and diluted [5].

Stephen H et al. [4] studied various injection rates through the pencil point needles using hyperbaric dye in a spinal cord model. They found that the injection rate had a significant effect on peak dye concentration. A slow injection caudally two ml and four ml/min produced much higher concentration of dye in the sacral distribution, whereas faster injection produced lower concentration of the dye because of turbulence, resulting in more mixing and dilution. No further dilution occurred once a rate of 6 ml/min exceeded and this was similar whether the needle was 24G Sprotte or 27G Whitacre [4]. The present study also documented the same phenomenon.

In the present study, maximum height of the block was achieved

T6 level	T4 level
Group Q – 38%	Group Q – 0%
Group S – 88%	Group S – 0%
Group W – 56%	Group W – 32%

Inferring that the height of the block is significantly higher in Group III $p<0.001$ when all three groups were compared. Comparing Group I and II, it is higher in Group II compare to Group I.

The present observation can be explained by the documented study of Serpell M.G et al. [6] They examined the flow pattern produced when liquid dye was actively injected into a fluid medium at various flow rates through five different spinal needle from 3 different manufacturers. At all flow rates Whitacre type needles produced a unidirectional stream exiting at an angle from the longitudinal axis. At intermediate rates the stream developed tracks which disappeared at a faster rates. Sprotte needle also produced undeviated tracks with two vertical tracks originating from the proximal and distal border of the orifice.

The Quincke needle always produced an undeviated stream of the dye and did not form any track at any flow rate. When a Perspex plate representing spinal cord was interposed in front of the needle, the dispersion of the dye was always unidirectional from Whitacre needle, unidirectional with two tracks from Sprotte needle, bidirectional from Quincke needle. The dye adhered to the surface of the plate as concentrated film at slow rates and at faster rate it dispersed turbulently for both type of needles.

They concluded that the dye from pencil point needles exhibited at an angle of emergence and unidirectional distribution when obstructed, at specific flows (3-6 ml/min) track formation and contact adherence were observed. These characteristics may produce clinical effect on the distribution of local anaesthetic during spinal anaesthesia [6].

The present study is also comparable to study done by Stephen H.J. et al., in which they studied the hyperbaric dye solution distribution characteristic after pencil point injection in a spinal cord model. Spinal needle 24 Gauge Sprotte, 25G Sprotte, 25 Gauge Whitacre and 27G Whitacre were used. All the needle characteristics including injection rates through various needles were studied using digital video imaging technique. It was found that injection rate had significant effect on the peak dye concentration. The lowest injection rate had highest concentration. Injection rate greater or equal to 6 ml/min resulted in peak dye concentration. Needle type also had effect on peak dye concentration. Injection via 24 G Sprotte needle has larger orifice area and internal diameter resulted in significantly lower concentration than via smaller Gauge Whitacre needle [4].

Present study	T8 at 5 mins	T6 at 5 mins	Max ht T6	Max ht T4
Group I	20%	0%	28%	0%
Group II	66%	14%	88%	0%
Group III	68%	20%	56%	32%

Anderson L et al. [5]	Duration of onset	Ht of block
Slower group	20 min	T3.5
Faster group	30 min	T4

Stephen et al. studied the effect of injection rate on peak dye concentration using hyperbaric dye in spinal cord model.

Needle [4]	2 ml/min	4 ml/min	6 ml/min	8 ml/min
24G Sprotte	229 + 10	201 + 19	147 + 9	131 + 4
25G Sprotte	248 + 2	228 + 5	138 + 8	137 + 3
25G whitacre	289 + 4	210 + 16	159 + 18	145 + 3
27G whitacre	303 + 10	200 + 28	142 + 3	137 + 3

Analysis of the present study with the study done by Stephen H.J. et al. and Anderson L revealed that onset of sensory block was earlier with pencil point needles.

In a present study, regression of the block was assessed by Bromage scale. It is similar in all three group p value being.

0.855 Grade I
0.856 Grade II
0.856 Grade III
0.124 Grade IV

It is inferred that the regression of block was similar in all three groups. The present study was comparable to a study done by Anderson. L. et al. where the return of normal sensory function in the slow group was an artefact as a recovery profile of the sensory block was identical for both groups until 180 min [5].

In the present study, though the height of block achieved was more in Group II and Group III, regression of the block is similar to all three groups. This could be artefact it is not possible explain how a motor block of more height produced by the same agent could wear off in the same time as with the lesser height block. PDPH is a disturbing complication to the patient, surgeon and anaesthesiologist because it is common and disabling to the patient.

A failed technique was defined has the lack of acceptable anaesthesia for the proposed surgical procedure following injection of local anaesthetics after free flow of CSF was identified with any spinal needle. Crone [7] had also compared 22G and 24G Sprotte needles with 22G, 25G and 27G Quincke needles. Sprotte needle had 10.3% failure compare to 4.3% of Quincke needle [7].

Possible explanation for the difference of incidence of PDPH in different types of needle are relates to the design of the needle; specifically the dimension and the placement of the side port allowing free flow of CSF and deposition of local anaesthetic solution in both the subarachnoid and epidural space which leads to an inadequate block.

Serpell MG [6] studied flow dynamic through spinal needle which explains the characteristic of the Sprotte needle it exits about 30^0 in the range of 3-6 ml/min 2 vertical tracks originate from the proximal and distal borders of the orifice.

Post-operative back pain is common complication after spinal anesthesia. The reported incidence has been about 20%. However, it should be noted that back pain occurs as frequently after general anesthesia as after spinal anesthesia. The mechanism for the production of post-operative back pain seems to be the relaxation of the paraspinous muscle under anesthesia and result in flattering of the normal lumbar convexity and stretching of the inter lumbar lumbo sacral ligaments and joint capsules, particularly in lithotomy position [8,9,10].

Conclusion

After detailed study in reference to available previews; it is concluded that pencil point needle, that is, 27 Gauge Whitacre and 27 Gauge Sprotte are associated with early onset of sensory block; the height of the block achieved being greater and incidence of PDPH low when compared to cutting type of Quincke needle. All three types of needles are easy to insert when used with an introducer.

However, failure rate with Sprotte needle is more when compared to Whitacre needle and Quincke needle which limits the use of the same.

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