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Research article

Efficacy of different size Quincke spinal needles in reduction of incidence of Post-Dural Puncture Headache (PDPH) in Caesarean Section (CS). Randomized controlled study

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ABSTRACT

Background: Regional analgesia first introduced in clinical practice by the German surgeon Karl August Bier (1898). Spinal, epidural or combined spinal and epidural anaesthesia became the first line of choice in obstetric surgery. PDPH was found to be more frequent after Caesarean Section in young parturients. Also PDPH is related to CSF leakage from the subarachnoid space.
Objectives: This prospective, double blinded, randomized study compares the frequency of PDPH following spinal anaesthesia for CS and technique difficulty with 22G, 25G and 29G Quincke needles.
Methods: One hundred and eighty ASA I and II full term pregnant females aged 20–40 years, scheduled to receive spinal anaesthesia for elective CS, were randomly divided into three equal groups (n = 60 each). Each group received spinal anaesthesia with 22G (GI), 25G (GII) and 29G (GIII) Quincke needle. Difficulty in localizing the subarachnoid space and time taken to administer spinal anaesthesia were noted. Postoperatively; incidence, onset, site, duration and severity of headache were also studied.
Results: PDPH occurred in 19 patients (31.7%) in GI, 7 patients (11.7%) in GII and 0 patients in GIII. However, the time taken to get CSF from onset of needle insertion was significantly different between the three groups; {13.6(5.2), 28.7(11.1) and 113.5(27.4) sec. mean(SD) in GI, GII and GIII} respectively. The duration of local anaesthetic injection through the spinal needles was significantly different between the three groups; {9.3(0.6), 15.3(1.2) and 37.4(1.7) sec. mean(SD); GI, GII and GIII} respectively. Also time to reach T4 block was significantly longer in GIII when compared with other groups; {5.7(0.8), 5.7(1.1) and 8.0(0.7) min. mean(SD); GI, GII and GIII} respectively. $P < 0.05$. Conclusion: Spinal anaesthesia with a 29G needle reduced the incidence of PDPH in elective CS to 0%. However, it is significantly more time consuming to give spinal anaesthesia with 29G needle than with the other needles.

1. Introduction

Regional analgesia was first introduced in clinical practice by the German surgeon Karl August Bier (1898), who injected cocaine into subarachnoid space of seven patients, himself and his assistant, Hildebrandt [1]. Then, it became widely practiced to provide anaesthesia, especially for surgery below umbilicus. Regional anaesthesia (spinal, epidural or combined spinal and epidural) became the first line of choice in obstetric surgery. Its preference is because of its advantages over general anaesthesia. These advantages include: easy technique, rapid onset, simple performance, requirement of minimum equipments and monitors, little effects on blood biochemistry, optimum levels of arterial blood gases, conscious patients during surgery and maintenance of airway patency, less post operative care and provide good analgesia [2]. Unfortunately regional anaesthesia has some complications that may be severe enough to annoy the patient, surgeon and/or the anaesthetist. Post-Dural Puncture Headache (PDPH) has remained a well-recognized complication. PDPH does not occur in all patients who received lumbar puncture for diagnostic or anaesthetic reasons and is found to be more common after Caesarean Section (CS) in young parturients [3,4]. For many years ago less refined and thicker spinal needles were being used and the incidence of PDPH was high [4–6]. But within the last three decades more refined and thinner needles of 25-31G have been

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used more often and the incidence of PDPH is reduced to be 0–5% [7–11]. Although it may be transient, mild PDPH may persist for hours or many weeks and can be severely incapacitating [2]. Previous studies have reported a reduced incidence of headache in young patients with the use of a 29G needle, with the incidence varying between 0% and 2% [7–9].

The present study was undertaken to compare the use of 22G, 25G and 29G Quincke point needles in three groups of full term pregnant females scheduled for CS under spinal anaesthesia with regard to the frequency and severity of PDPH and the difficulty in performing spinal anaesthesia.

2. Material and methods

After approval by the hospital ethical committee, informed, written consent was obtained from 180, ASA Physical Status Grade I and II, full term pregnant females with a single uncompromised foetus and uncomplicated pregnancy, admitted to Misr University for Science and Technology (MUST) Hospital from January, 2014 to December, 2015. These women were selected randomly by computerized randomization table from the age group of 20–40 years, were scheduled to receive spinal anaesthesia for elective CS and divided into three equal groups (n = 60 each). Each group received spinal anaesthesia with 22G (GI), 25G (GII) and 29G (GIII) Quincke needle.

All patients in the three groups were blind for the size of the needle used for spinal anaesthesia. Patients with abnormalities of spine, soft tissue infection at the site of needle insertion, respiratory tract infection, coagulation disorders or anticoagulant therapy, foetal distress, pregnancy induced hypertension, cardiovascular or neurological disorders, emergency CS, Body Mass Index (BMI) > 30 and history of PDPH or any type of headache were excluded.

All the patients were visited a day before surgery and were informed of the procedure and the possibility of less than 5% risk of developing a post-spinal headache as a result of the procedure. A thorough and detailed history of present and past medical illness, past history of anaesthetic exposure with concomitant history of drugs taking in preoperative period was also recorded. General and airway examination of all patients was done. Investigations including; Complete Blood Count (CBC), Liver and Kidney functions and coagulation profile were done. Ranitidine 50 mg and Metoclopramide 10 mg were given i.v. slowly (through 18G i.v. catheter) 1 h before surgery. In the operating room, ECG, Heart Rate (HR), Non-Invasive Blood Pressure (NIBP) and Pulse Oximetry were monitored by LifeScope (NIHON KOHDEN CORPORATION 1-31-4 Nishiochiai, Shinjuku-ku, Tokyo, Japan).

After preloading the patients with 20 ml/kg of Ringer's acetate over a period of 20 min, spinal anaesthesia procedure was performed in sitting position by the same anaesthesiologist at L3-4 or L4-5 intervertebral space. The patients were given a standard spinal anaesthetic consisting of 10–12.5 mg (2.0–2.5 ml) of 0.5% Bupivacaine in 8.25% dextrose (Hyperbaric Bupivacaine) and 25ug Fentanyl (total volume 2.5–3 ml) by either a 22G × 90 mm needle in group I (GI), 25G × 90 mm needle in group II (GII) or 29G × 90 mm needle in group III (GIII) (UNISIS CORP.JAPAN). After sterilization of the patient's back and draping it with sterile towels, subcutaneous infiltration of 2 ml 2% lidocaine was done using 25G insulin needle followed by 23G × 1¼″ needle for deeper block through midline approach. Spinal needles were introduced with the needle tip bevel directed laterally. In GIII, 29G spinal needle was very thin and weak to pierce the skin and ligaments by itself, so a 22G × 38 mm introducer was included within the set of 29G needle to facilitate insertion of spinal needle through it into the subarachnoid space. Subarachnoid space was reached when the CSF flows back through the spinal needle. We used 3 ml syringe for injection of local anaesthetic in the subarachnoid space to complete the double blindness of the study (blindness of the patient). After withdrawal of the needle, the patient was turned to the supine position with left uterine displacement. The level of block was tested with the help of a spirit swab for sensory block and Bromage motor score for motor block [2]. The level of block was recorded 5–10 min after drug injection and was reached T4-6 sensory dermatome before surgical incision. All patients were administered O_2 by nasal prong at a flow rate of 5 l/m intraoperatively.

Heart Rate (HR) and Mean Arterial Pressure (MAP) were observed before spinal anaesthesia, every two minutes after spinal anaesthesia for the first ten minutes and then every five minutes thereafter till the end of surgery. ECG and oxygen saturation were monitored throughout the surgery.

Maintenance fluid at the rate of 10 ml/kg/hour was administered intra-operatively. Fall in systolic blood pressure below 100 mmHg or 20% of the baseline value was treated with rapid administration of i.v. fluids and 5–10 mg of Ephedrine given intravenously. Complications like nausea, vomiting, bradycardia (pulse rate below 60 beat/min), respiratory depression (respiratory rate below 8 breath/min) &/or skin reaction (i.e.; itching, erythema or pruritus) were managed symptomatically. Postoperatively, all the patients were mobilized after haemodynamic stability and return of sensation and motor power. A different anaesthesiologist not knowing the type of needle used did postoperative observations. Patients were interviewed on days 1, 2, 3, 4, 5 postoperatively and were questioned about headache; its onset, severity, location, character, duration, associated symptoms like nausea or vomiting.

Criteria of post dural puncture headache are; It occurs after mobilization 6–12 h postoperatively, aggravates by: erect or sitting position, coughing, sneezing or straining, relieves by; lying flat, good hydration and analgesics, and mostly localized in occipital, frontal region or generalized.

Severity of headache was assessed on 1–4 scale [2]:

1. Mild headache which permitted long periods of sitting/erect position and no other symptoms.
2. Moderate headache, which made it difficult for the patient to stay upright for more than half an hour. It occasionally accompanied by nausea, vomiting, auditory and/or ocular symptoms.
3. Intense headache immediately upon getting up from bed, alleviated while lying horizontal in bed. Often accompanied by nausea, vomiting, ocular and auditory symptoms.
4. Headache that occurred even while lying horizontal in bed and greatly aggravated immediately upon standing up, eating is impossible because of nausea and vomiting.

PDPH when present was treated with bed rest, Diclofenac 75 mg i.m., good hydration, paracetamol (1 gm in 100 ml) vial i.v. infusion and/or Epidural Blood Patch (EBP).

2.1. Statistical analysis

Data were collected and statistically analyzed using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 22. One-way repeated-measures Analysis of Variance (ANOVA) with post hoc Bonferroni correction was used to assess differences in mean between groups. Mann-Whitney U and Chi square (x^2) tests were used to analyze ordered and nominal data respectively. Data are expressed as mean values ± SD or number (%). P values <0.05 were considered statistically significant. The current study found a frequency of post-dural-puncture headache of 31.7% with 22G spinal needle (GI), 11.7% with 25G spinal needle (GII) and none of the cases with 29G spinal needle (GIII). Based on these results the effect size is 0.372 which have a 99% power of the Chi-square test at an alpha level of 0.05. The power

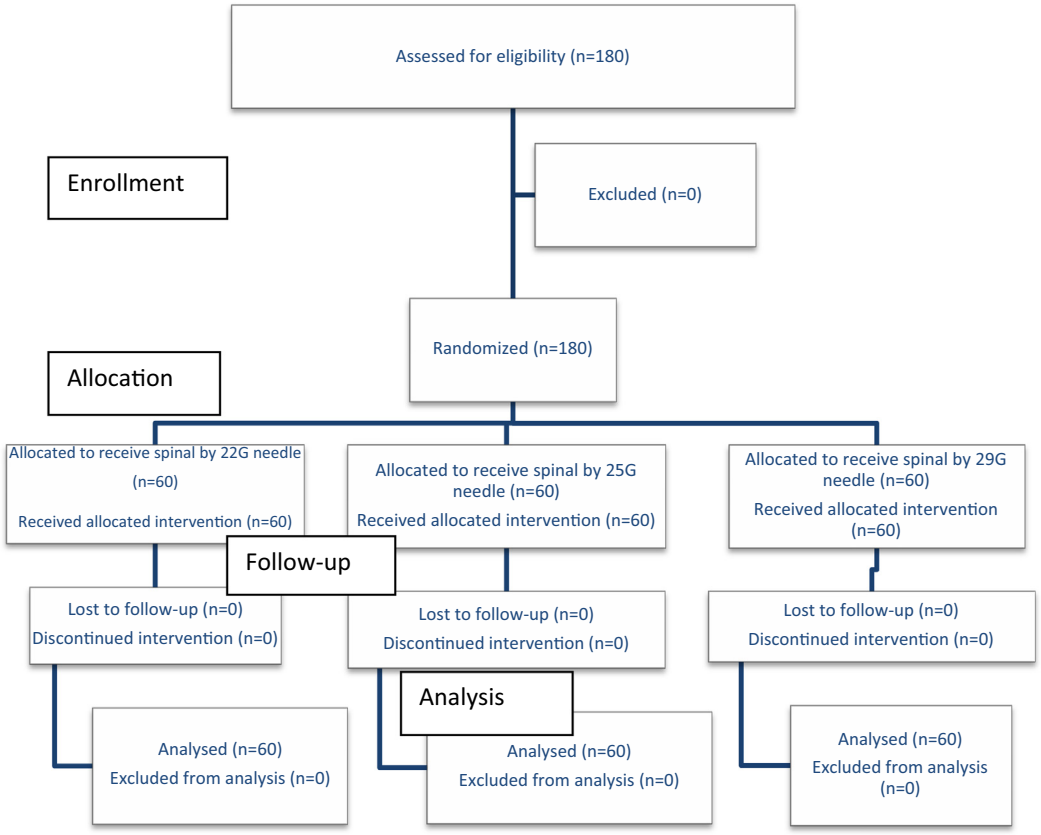

Figure 1. CONSORT diagram showing the flow of participants through each stage.

was estimated using the G*Power© software (Institutfür Experimentelle Psychologie, Heinrich Heine Universität, Düsseldorf, Germany) version 3.1.9.2 (see Figs. 1 and 2).

3. Results

There were sixty patients in each group and all the groups were comparable with regard to ASA physical status, age, BMI and baseline data; MAP, HR, O_2 saturation and level of block (Table 1).

The incidence of PDPH was statistically significant between groups with 0 patients (0%) in GIII (29G) versus 19 patients (31.7%) in GI (22G) versus 7 patients (11.7%) in G II (25G). P value <0.05 (Table 2).

The PDPH onset, site, severity and duration were comparable between GI (22G) and GII (25G). Only one out of the seven patients with headache in GII developed severe headache which was treated without Epidural Blood Patch (EBP) (Table 2).

The mean onset of PDPH in this study was 22.15(13.85) h (range 6–48 h in the two groups) after dural puncture with no significant difference between GI and GII (Table 2).

Duration of headache ranged from 2 to 7 days post-operatively with a mean duration of 4.3(1.55) days and no significant difference between the two groups (GI and GII) (Table 2).

The difference in number of trials to reach subarachnoid space was not statistically significant between the three groups (Table 3).

The time taken to get CSF from onset of needle insertion into the skin was significantly different between the three groups and GIII (29 g needle) was the longest, {13.6(5.2), 28.7(11.1) and 113.5 (27.4) (sec.) mean(SD) in GI(22G), GII(25G) and GIII(29G)} respectively. P < 0.05 (Table 3 and Fig. 3).

Also the duration of local anaesthetic injection through the spinal needles was significantly different between the three groups being longest in GIII (29G), {9.3(0.6), 15.3(1.2) and 37.4(1.7) (sec) mean(SD); in GI(22G), GII(25G) and GIII(29G)} respectively. P < 0.05 (Table 3and Fig. 3).

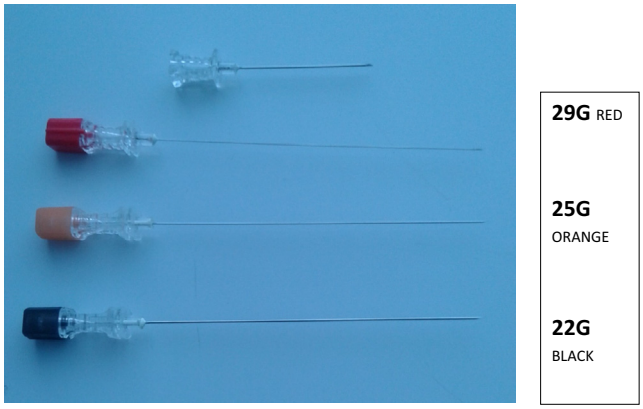

Figure 2. Different size Quincke spinal needles.

Table 1
Demographic and baseline data (MAP, HR, O_2% & level of block).

	GI(22G) (n = 60)	GII(25G) (n = 60)	GIII(29G) (n = 60)
ASA(I/II) (n/n)	55/5	58/2	56/4
Age (yr)	27.8(5.7)	27.3(4.9)	27.6(5.0)
BMI (kg/m^2)	25.8(5.2)	26.2(4.8)	25.6(5.0)
MAP(mmHg)	70.6(5.4)	72.5(5.8)	69.8(4.9)
HR (beat/min)	90 ± 10	85 ± 7	88 ± 9
O_2 Saturation (%)	98 ± 2	99 ± 1	99 ± 1
Level of block (median(range))	T4(T3-T8)	T4(T3-T6)	T4(T2-T6)

Data are expressed as mean(SD) or numbers (n) or (%) or median (range).

Table 2
Post-Dural Puncture Headache (PDPH).

	GI(22G) (n = 60)	GII(25G) (n = 60)	GIII(29G) (n = 60)
Incidence:			
n(%)	19(31.7)*	7(11.7)*	(0)*
0nset:(h)			
mean(SD)	24.6(13.5)	19.7(14.2)	
Range	12–48	6–48	
Site of headache: n(%)			
Occipital	9(47.4)	2(28.6)	
Occipitofrontal	5(26.3)	3(42.9)	
Frontal	5(26.3)	2(28.6)	
Severity:n(%)			
Mild	9/19(47.4)	4/7(57.1)	
More than mild:	10/19(52.6)	3/7(42.9)	
Duration (days):			
mean(SD)	4.2(1.5)	4.4(1.6)	

* P value <0.05.

Table 3
Techniques of spinal anaesthesia.

	GI(22G) (n = 60)	GII(25G) (n = 60)	GIII(29G) (n = 60)
No. of trials:			
One n(%)	49(81.7)	51(85.0)	43(71.7)
>One n(%)	11(18.3)	9(15.0)	17(28.3)
Time to get CSF:			
(sec) mean(SD)	13.6(5.2)*	28.7(11.1)*	113.5(27.4)*
Duration of inj. Of L.A.:			
(sec) mean(SD)	9.3(0.6)*	15.3(1.2)*	37.4(1.7)*
Time to get T4 block:			
(min) mean(SD)	5.7(0.8)	5.7(1.1)	8.0(0.7)*

CSF = Cerebro-Spinal Fluid.
L.A = Local Anaesthetic.
* P value <0.05.

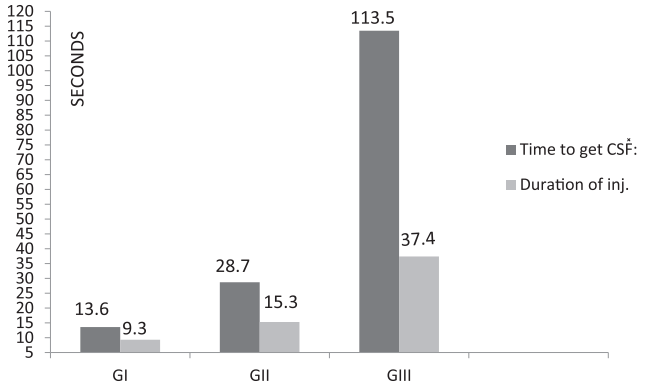

Figure 3. Time to get CSF, and duration of injection of local anaesthetic (sec) in different groups.

Time to reach T4 block from withdrawal of spinal needle and lying the patient supine was statistically significant in GIII (29G) when compared with the other groups, {5.7(0.8), 5.7(1.1) and 8.0 (0.7) (min) mean(SD); in GI(22G), GII(25G) and GIII(29G)} respectively. P < 0.05 (Table 3).

4. Discussion

The PDPH is due to a low CSF pressure caused by CSF loss through the dural puncture hole and failure of choroid plexus to secrete sufficient fluid to maintain the CSF pressure. Also the negative pressure in the epidural space may draw CSF from subarachnoid space. This leads to CSF hypotension, which in turn leads to intracranial venous dilatation resulting in an increase in brain volume in the upright position. A difference in CSF volume and pressure occurs between the intracranial and intervertebral part of the subarachnoid space. Venous dilation and compensatory increase in brain volume will exert traction and stimulate pain sensitive structures like dural vessels, basal dura and tentorium cerebelli, causing post spinal headache. The larger the hole in dura mater, the more will be the leakage of CSF and the longer the time required for repair. Also the number of holes in the dura makes a difference in the loss of CSF. It takes about two weeks or more for the holes to close [1,2].

The overall incidence of distressing post spinal headache has varied from <3% to 75%, as reported by various authors [1,12–14]. The most important factor contributing to the higher incidence of PDPH was the gauge and type of needles used. The thicker the needle, and the more traumatic the type of needle (cutting type), the more the incidence of post spinal headache [4,5,12]. The observed incidence of PDPH in our study was 31.7% in GI (22 g), 11.7% in GII (25 g) and 0% in GIII (29 g). The difference was statistically significant. In a study by Hwang et al. [10] the incidence of headache was 1.06%, 3.65% and 2.08% with 25G Whitacre, 25G Quincke and 26G Quincke needle respectively, which is much less than our results. Grover et al. [8] found an incidence of 24% in 25G Quincke group and 4% in the 29G Quincke group in 50 non-obstetric patients in each group, and this was higher than expected in non-obstetrics. In a double blind study in young volunteers, Tourtelotte et al. [15] found a reduction of headache from 36% to 12% when a 26G instead of a 22G needle was used which is comparable with our results. In a controlled study, Flatten et al. [9] reported a reduction in incidence of headache from 10% to 0% when a 29G instead of a 26G needle was used for spinal anaesthesia in patients less than 30 years of age in non-obstetrics, this goes with our results in obstetric patients. In a prospective study of 80 patients under 40 years of age, the incidence of PDPH was 25% with a 25G needle with no headache in the 29G group [16]. Vallejo et al. [17] selected one thousand two women undergoing elective CS under spinal anaesthesia. They used two cutting needles: 26-gauge Atraucan and 25-gauge Quincke, and three pencil-point needles: 24-gauge Gertie Marx (GM), 24-gauge Sprotte, and 25-gauge Whitacre. The incidences of PDPH were, respectively, 5%, 8.7%, 4%, 2.8%, and 3.1% for Atraucan, Quincke, GM, Sprotte, and Whitacre needles. Tabedar et al. [18] compared between 25G Quincke and 26G Eldor needles in elective CS and found PDPH incidence of 8.3% in 25G group and 0% in 26G group. Sohail et al. [19] compared between 25G and 27G Quincke needles in elective CS and found PDPH incidence of 8.33% in 25G group and 2.04% in 27G group. These studies proved the inverse relationship between the incidence of PDPH and the needle gauge (i.e. as the needle gauge increases the incidence of PDPH decreases).

The mean onset of PDPH in this study was 22.15(13.85) h (range 6–48 h in the two groups) after dural puncture with no significant difference between GI and GII. This early onset may be related to the early ambulation of the patients after 6 h of surgery. In a study by Shutt et al. [13], onset of headache was from 18 to 57 h after dural puncture. Shah et al. [2], reported an onset of PDPH ranged from 24 to 72 h after dural puncture, because they kept their patients recumbent for the 1st 24 h postoperatively.

The site of headache in our study was frontal or occipital or generalized with no significant difference between groups or within the same group. Shah et al. [2], reported in 8 out of the 9 patients who had PDPH, the location of headache was in frontal region. Only one patient had generalized headache. In a study by Jones [20], the incidence of frontal, parietal, occipital and generalized headaches were 50.0%, 1.4%, 25.0% and 23.6% respectively.

Duration of headache ranged from 2 to 7 days post-operatively with a mean duration of 4.3(1.55) days and no significant difference between the two groups (22G and 25G). Shah et al. [2], found a mean duration of headache of 27.77 h (range 24–48 h), and in 8 out of 9 patients, who had PDPH, the duration of headache lasted less than 24 h. In only one patient, the duration of headache was up to 48 h. This mean duration of headache was short when compared with the mean duration of our study. In a study by Lynch et al. [21], the median duration of headache was 48 h (range 24–64 h) and 57.5 h (range 8–80 h) in the 25 and 22 gauge groups respectively.

Patients who developed PDPH had mild or moderate headache, one patient in group II (25G) developed a severe headache. In a study of Dittmann and Renkl [22] a decreased severity of headache was noted in the 29G group Quincke needle. Moderate form of headache was observed in 1 and 6 patients in 29 and 26G groups respectively. Once the patient had headache, he was instructed to take complete bed rest, treatment with Diclofenac Sodium i.m. (75 mg) and Paracetamol (1gm vial) i.v. infusion over 15 min. every 6–8 h, and hydration therapy. All the patients responded with this treatment and none of the patients required EBP. There is a universal consensus about the fact that the thicker the lumbar puncture needles, the higher could be the incidence of PDPH. A cutting type of needle inserted through the dural wall tears off a number of fibers in the wall and a permanent opening in it is ensured. The puncture site has typical crescent like appearance produced by the cutting type of needle. The anatomical feature of dura is such that longitudinal dispersion of its fibers plus a copious interspersion of elastic fibers keeps the hole open once the dural fibers are cut [19]. Pan et al. [23] suggested the use of a pencil point lumbar puncture needle and the tip of the pencil point needle separates the longitudinal dural fibers without producing serious injury. When the needle is withdrawn the fibers return to a state of close approximation. In the present study, the bevel of the needle was inserted parallel to the longitudinal dural fibers, so that these fibers are separated and are not damaged and a narrow slit like opening is obtained, with a greater tendency to contraction and plugging of the hole, decreasing the leakage of CSF. In a study by Lybecker et al. [24] the incidence of PDPH among patients in whom the bevel was inserted parallel to the longitudinal dural fibers was 0.56 times the incidence among patients in whom the bevel was inserted perpendicular to the longitudinal dural fibers.

There are a few studies, which examined the technical difficulties involved in the use of different spinal needles. In the present study there was no significant difference between the three groups regarding successful dural puncture following a single needle insertion with the highest incidence in 25G GII (85.0%), on the other hand 29G needle was associated with the highest incidence of multiple trials (28.3%). Shah et al. [2] found that the 25G Quincke needle was associated with the greatest incidence of successful dural puncture following a single needle insertion (100%), the 27G Quincke needle was associated with 4% failure rate, and the 27G Whitacre needle was associated with the greatest failure rate (12%). Needle deformity seems to be one of the major causes of difficulties, especially 29G needles which are highly flexible [25]. We had no failure with the needles used in this study and we believe the routine use of a spinal introducer was an important factor for maintaining direction during spinal needle introduction [26].

Time to the appearance of CSF out of the hub of the needle was significantly different between the three groups, 13.6(5.2) sec in 22G GI versus 28.7(11.1) sec in 25G GII versus 113.5(27.4) sec in 29G GIII, $P < 0.05$. In a study by Shah and Bhosale [27] CSF detection time was significantly prolonged ($P < 0.0001$) with smaller-gauge needles, irrespective of the tip design which is related to a smaller internal diameter of the needle. Shah VR detected CSF after 20.9(4.6) sec in 25G Quincke needle and after 35.2(17.6) sec in 27G Quincke needle. These results agree with our results.

Duration of injection of local anaesthetic into the subarachnoid space was also significantly different between the three groups, 9.3 (0.6) sec in 22G GI versus 15.3(1.2) sec in 25G GII versus 37.4(1.7) sec in 29G GIII, $P < 0.05$. This prolongation of duration of injection of the same volume of local anaesthetic with the increasing needle gauge was related to the increased resistance to injection due to decreased internal diameter of the more fine needles.

Time to get T4 sensory block was significantly prolonged in 29G GIII when compared with the other two groups, 8.0(0.7) min in 29G GIII versus 5.7(0.8) min in 22G GI and 5.7(1.1) min in 25G GII, $P < 0.05$. This delay in 29G GIII to reach T4 dermatome sensory block was related to the prolonged injection time, this extra time of sitting position allows the hyperbaric local anaesthetic to settle down in the subarachnoid space and so took more time to rise up after the patient lay supine. The overall time of induction of spinal anaesthesia increased with increasing spinal needle gauge, this was not related to difficulty in the needle insertion but related to the decreasing internal diameter of the smaller needles, and this should not be a drawback to use high gauge needle 29G in CS when compared with the near 0% incidence of PDPH.

Post-Dural Puncture Headache is due to loss of CSF through the dural hole [28,29]. Increase in blood volume by means of hydration facilitates choroid plexus to produce more CSF. Therefore increase in the cerebrospinal fluid pressure by means of increasing the production of CSF will neutralize the loss due to leakage and when the balance is maintained, there should be no post-spinal headache. All the patients were hydrated in a similar manner. Two studies have expressed the opinion that early ambulation does not enhance the incidence of PDPH nor does it increase the severity of the syndrome [20,30]. The incidence of PDPH is more common among women than men, particularly prone are the parturients [3,4], because of the reduction of both the intra abdominal and epidural pressure after delivery, thereby promoting extra leakage of CSF than usual. Sex bound difference is caused by emotional and hormonal factors. The factors responsible for an increased incidence of PDPH in obstetric patient include stress of labour, changing hormonal level and dehydration. Because of this reason this study was conducted only in the cases of CS [2,31,32].

In conclusion, Spinal anaesthesia with a 29G needle reduces the incidence of PDPH in CS to 0%. However, it is technically more time consuming to give spinal anaesthesia with a 29G needle than with a 25G needle than with 22 g needle, but not difficult with the experienced hands.

Conflict of interest

The authors declare no conflict of interest about this study.

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