Original Research Article

Indian Journal of Anesthesia and Analgesia
2019; 6(2) (Part - II): 563-569
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.6219.30

Evaluation of 25 Gauge Quincke and Whitacre Needles on Technical Problems and Post Dural Puncture Headache: A Prospective, Observational study

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Abstract

Present study designed to evaluate and compare the role of 25 gauge Quincke and Whitacre spinal needles on technical difficulties and incidence of Post dural puncture headache in 18 to 65 years of age group patients, undergoing surgeries under spinal anesthesia. One hundred and fifty patients of American Society of Anesthesiology physical status grade I, II and III, aged between 18-65 years of either sex, undergoing elective surgical procedures under spinal anesthesia, were enrolled for the study period. In group Q 75 patients received spinal anesthesia through a Quincke needle. Whereas, in group W, 75 patients received spinal anesthesia through a Whitacre needle. PDPH was assessed in all patients including associated symptoms and numeric Pain Rating Scale. It was concluded that shape of the tip of the needle has no effect either on the number of attempts for a successful intrathecal anesthesia or on the incidence and severity of postdural puncture headache. The overall incidence of post dural puncture headache is 2.7% and we did not observe any difference between 25G Quincke and 25G Whitacre needle on the incidence of PDPH (2.7% in both groups).

Keywords: headache; intrathecal anesthesia; Quincke and Whitacre needles; analgesia.

How to cite this article:

K. Brinda, Aloka Samantaray, Mangu Hanumantha Rao. Evaluation of 25 Gauge Quincke and Whitacre Needles on Technical Problems and Post Dural Puncture Headache: A Prospective, Observational study. Indian J Anesth Analg. 2019;6(2):563-569.

Introduction

Post dural puncture headache (PDPH) is a well-known complication of spinal anesthesia. It occurs after spinal anesthesia induction due to dural and arachnoid puncture and has a significant effect on the patient's postoperative well - being. Spinal anesthesia also called spinal analgesia or subarachnoid block is a form of regional anesthesia and a kind of central neuraxial block involving injection of opioids, local anesthetics or other permissive drug into the subarachnoid space [1,2].

The first spinal anesthetic was delivered by an accident. Its inception can be traced back in the late 19th century by James Leonard Corning. He reported on spinal anesthesia in 1885 for the first time. The first planned spinal anesthesia was administered by August Bier in 1898. He had personal knowledge of the symptoms of post spinal puncture headache (PSPH). Bier reported complications including back and leg pain, vomiting and headache. Even at this early stage, he had associated the loss of cerebrospinal fluid with post spinal headache [3,4].

Post-spinal puncture headache (PSPH) is

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Received on 02.01.2019, **Accepted on** 02.02.2019

known by various names like post- dural puncture headache (PDPH), post lumbar puncture headache, lumbar puncture headache, post-spinal headache and spinal headache.

Post dural puncture headache (PDPH) is one of the recognized complications experienced with spinal anesthesia, resulting from needle puncture of the dural layer of the meninges [5]. This deliberate puncture during spinal anesthesia may allow a continuous cerebrospinal fluid (CSF) leak through a dural tear, leading to the characteristic syndrome of PDPH [6,7] also known as a spinal headache or low-pressure headache. The greater the leakage of CSF, the more severe and persistent is the headache. This is why larger needles (lower gauge) are known to have a higher incidence of PDPH. However, the type of needle also seems to play an important role in the likelihood of PDPH. Atraumatic (Whitacre) needles, with their characteristic pencil point tip may prove superior to traumatic (Quincke) needles in terms of reducing incidence of PDPH.

Materials and Methods

This was a prospective observational study over a period of ten months conducted in various surgical operation theatres of Sri Venkateswara Institute of Medical Sciences (SVIMS) university teaching hospital. Study was performed after obtaining approval from the Institutional Ethics Committee (IEC) with IEC No: 361/ dated : 25.03.2014.

Study population: One hundred and fifty patients of American Society of Anesthesiology physical status (ASA) grade I, II and III, aged between 18-65 years of either sex, undergoing elective surgical procedures under spinal anesthesia, were enrolled for the study period was from Jun 2014 to March 2015.

Inclusion Criteria: ASA physical status grade of I, II and III; Age 18-65 years; BMI<30 Kg/m^2.

Exclusion criteria: Patients not willing to participate in the study; General contraindications to central neuraxial block; Patients with spinal abnormalities; Patients who had spinal surgeries previously; Patients with a history of headache; Pregnant and lactating mothers.

Intervention: Under local anesthesia, 18 G/20G cannula was inserted into a large vein for intravenous fluids and drug administration.

Randomization: The random number sequence was generated before enrolling the study participants.

Group Q (n=75): patients received spinal anesthesia through a Quincke needle.

Group W (n=75): patients received spinal anesthesia through a Whitacre needle.

Anesthesia technique: All patients received premedication of tab. alprazolam 0.25 mg orally on the night before surgery and was explained about the use of numeric rating pain scale. After arrival in the operating room, a peripheral intravenous (IV) cannula was secured.

The lumbar puncture was performed inside the surgical theatres for various surgical procedures requiring a planned spinal anesthesia as a part of the normal care. They were performed with the patient in the left lateral position at the L3/4 or L4/5 level and the stylet was replaced prior to needle withdrawal. With regard to the traumatic needles (Quincke) the bevel was inserted upwards (parallel to the long axis of the patient). All patients received 3-3.5 ml of 0.5% hyperbaric bupivacaine for achieving spinal subarachnoid block. Later all patients were placed in supine position with OT table in horizontal position. All patients received supplemental oxygen at the rate of 5 liters/minute through a face mask during the surgery. An infusion of lactated ringer's solution was administered during anesthesia and the rate of infusion was altered depending upon the haemodynamic response. Blood pressure was recorded at every two minutes for the first fifteen minutes and thereafter every 15 minutes till the end of surgery. Hypotension was defined as a decrease in systolic blood pressure by more than 20% of the base line or below 90 mmHg. Bradycardia was defined as an absolute decrease in heart rate below 50 beats per minute. Hypotension was treated with additional (100 mL) intravenous fluid (2 ml/Kg) repeated three times and if this failed to treat hypotension then additional bolus of intravenous (IV) ephedrine 6 mg was administered and repeated as required. Bradycardia was treated with IV atropine 0.6 mg and repeated when required.

Monitoring: One lead (II) continuous electrocardiogram (ECG); Heart Rate (HR) from ECG; Non-invasive blood pressure (NIBP); Systemic oxygen saturation by pulse oximetry.

Study Parameters: All the study participants were informed during the preoperative visit and once again after shifting the patient to their respective post anesthesia care units (PACU) about the posture dependent headache, i.e. one that would be aggravated by sitting and standing and getting relieved by lying down, was regarded as PDPH.

1. PDPH was assessed in all patients who received spinal anesthesia upto 5th Post - operative day (POP).
2. Associated symptoms like nausea, vomiting, dizziness, tinnitus, photophobia, diplopia and neck stiffness.

Questionnaire

i. Did you experience headache after your lumbar puncture (LP)?

ii. How long after the LP the headache started?

iii. Did the headache improve after lying supine?

iv. Was the headache is associated with any other associated symptoms?

v. Did you took any analgesic after the headache?

vi Did you report to a health care personnel about your headache and intensity of headache was assessed using a 11 point numeric rating scale and was graded for severity of which 0 signifies no headache, 1-3 indicates mild headache, 4-7 shows moderate headache, and more than 7 stands for severe headache (Fig. 1).

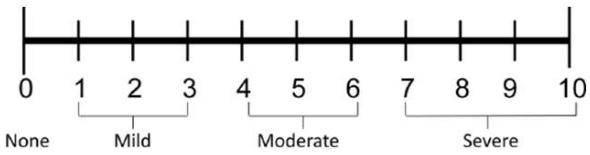

Fig. 1: The Numeric Pain Rating Scale

Number of attempts to introduce the needle in to subarachnoid space

3. Occurrence of Hypotension/Bradycardia/or the combination and the treatment given
4. Total amount of intravenous fluids administered during
   a. Intraoperative period
   b. First 24h postoperative period
5. Occurrence of nausea and vomiting

Statistical Analysis

1. Descriptive statistics for the categorical variables was performed by computing the frequencies (percentages) in each category.
2. For the quantitative variables, approximate normality of the distribution was assessed. Variables following normal distribution was summarized by mean and standard deviation (SD).
3. Independent student "t test" was used to compare the continuous variable between the two groups. Wilcoxon signed rank test (2 tailed) was used for non- normal distributed data.
4. Incidence of PDPH was represented as median (interquartile range) and was compared between two groups using a Median Mann Whitney U test.
5. Comparison of severity of PDPH between two spinal needles was analysed using a chi-square test.
6. A, p value <0.05 was considered statistically significant.
7. Statistical software IBM SPSS, Version 20, (IBM SPSS Statistics, Somers NY, USA) was used for all mathematical computations and statistical calculations.

Results

In our study one hundred and fifty patients of American Society of Anesthesiology physical status (ASA) grade I, II and III aged between 18-65 years of either sex, who underwent various elective surgical procedures under spinal anesthesia over a period of ten months i.e. from June 2014 to March 2015 were selected and randomly allocated into 2 groups of 75 patients each. Group Q (n=75) received spinal anesthesia through a Quincke needle and Group W (n=75) received spinal anesthesia through a Whitacre needle. Study groups were compared prospectively for number of attempts and incidence of postdural puncture headache.

In total four patients complained PDPH (2 from each group). The severity of headache was mild to moderate in nature. In all patients the headache resolved with bed rest and simple analgesics (Tab. Paracetamol)

During the conduct of study one from each group required supplementation with general anesthesia because of surgical reason (extension of incision to supra umbilical level) and these two cases were excluded from analysis.

As all the surgical procedures were predominantly urological procedures, male patients were more than female patients in our study.

Only one patient in Quincke group complained of Neck stiffness which resolved spontaneously over a period of 48 hrs. No other complications were noted in any other patients.

The mean age of patients in Quincke group was 46.6 ± 15.1 yrs and that of the patients in Whitacre group was 45.7 ± 13 years.There was no significant difference in age between two groups (p=0.701).

The Mean weight of the patients in group Quincke was 59.9 ± 10.6 kg and that of the patients in Whitacre group was 60.2 ± 10.2 kg. There was no significant difference between the groups (p value =0.881).

In Quincke group there were 62 male patients and 12 female patients where as in Whitacre group there were 58 males and 16 females. The difference in gender distribution was not statistically significant (p value=0.529).

Duration of Surgery: The mean duration of surgery in Quincke group was 80.68 ± 29.12 minutes where as in Whitacre group it was 82.23 ± 33 minutes. There was no statistically significant difference between the two groups (p value=0.762).

Two Segment Regressions: The mean time to two segment regression in Quincke group was 138.17 ± 21.6 min where as in Whitacre group was around 141.14 ± 19.87 min. There was no significant difference between the groups (p value=0.385).

The mean number of attempts in Quincke group was 1.33 and in Whitacre group it was 1.21. There was no significant difference between two groups (p=0.351). The maximum number of attempts was 4 for two cases in Quincke group and one case from Whitacre group.

Heart Rate: The mean base line heart rate in Quincke group was 75 ± 9.9 bpm and in Whitacre group was 73.77 ± 7.87 bpm. There was no statistically significant difference between the two groups (p value=0.377).

The systolic blood pressure in Quincke group was 127.63 ± 12.39 mm of Hg where as in Whitacre group it was 125.64 ± 12 mm of Hg. There was significant difference between two groups (p value=0.326).

The mean diastolic blood pressure in Quincke group was 74.18 ± 7 mm of Hg and for Whitacre group 73.35 ± 6.86 mm of Hg. There was no significant difference between two groups (p value=0.464).

The mean volume of intra operative fluid administered in Quincke group was 1278.37 ± 461.76 ml where as in Whitacre group was around 1282.43 ± 581.76 ml. There was no significant difference between the groups (p value =0.963).

The mean volume of post-operative fluid administered in Quincke group was 4146.28 ± 1036.83 ml where as in Whitacre group was around 4106 ± 929.49 ml. There was no significant difference between the groups (p value=0.804).

The mean volume of total fluid administered in Quincke group was 5424.66 ± 1209.61 ml where as in Whitacre group was around 5388.51 ± 1201.78 ml. There was no significant difference between the groups (p value=0.856).

Incidence of Bradycardia: In Quincke group out of 74 patients bradycardia was noticed in 5 patients where as in Whitacre group out of 74 patients 6 patients had bradycardia. There was no significant difference between the groups (p value=1.000).

Atropine Administration: The number of patients who received atropine in Quincke group was 5 out of total patients of 74 where as in Whitacre group also 5 patients received atropine There was no significant difference between the groups (p=1.000).

Six patients had bradycardia in Whitacre group but only five patients received atropine, because one patient had an episode of bradycardia for transient period (<5 sec) which resolved spontaneously.

In Quincke group out of total 74 patients 8 patients developed hypotension and in Whitacre group out of 74 patients only 7 patients had hypotension. There was no significant difference between two groups (p=1.000).

Ephedrine Administration: The number of patients who received ephedrine in Quincke group was 4 out of total patients of 74 where as in Whitacre group 5 patients received ephedrine There was no significant difference between the groups (p=1.000).

In Quincke group eight patients had hypotension but only four patients received ephedrine. Similarly seven patients had hypotension in Whitacre group but only five patients received ephedrine, because hypotension in these patients (2 from each group) resolved by administration of fluid bolus as per the study protocol.

Post Dural Puncture Headache: The number of patients who developed PDPH in Quincke group was 2 out of total patients of 74 where as in Whitacre group also 2 patients developed PDPH. There was no significant difference between the groups (p=1.000).

Table 1: The Day of Onset of Post Dural Puncture Headache

Onset	Quincke (n=74)	Whitacre (n=74)
Day 1 (n)	0	0
Day 2 (n)	1	2
Day 3 (n)	1	0
Day 4 (n)	0	0
Day 5 (n)	0	0

n=number of patients

In Quincke group postdural puncture headache started on 2nd day and subsided on 4th day in one patient and in another patient it started on 3rd day and subsided on 6th day.

In Whitacre group postdural puncture headache started on 2nd day and subsided on 5th day in one patient and in another patient it started on 2nd day and subsided on 7th day.

Table 2: Severity of Post Dural Puncture Headache

Severity*	Quincke (n=74)	Whitacre (n=74)
Mild (n)	0	0
Moderate (n)	2	2
Severe (n)	0	0

n=number of patients

*Severity scale. According to Numeric rating scale severity of Headache was graded 0= No headache

1-3=Mild headache

4-7=Moderate headache

>7=Severe headache

All the four patients from either group had moderate degree of headache which subsided with bed rest and simple analgesic (Tab. paracetamol).

Complications: Only one patient in Quincke group out of 74 patients complained of neck stiffness and no complications were noted in Whitacre group of patients

Discussion

We conducted a prospective study in 150 patients randomised to receive spinal subarachnoid block with either a 25G Quincke or 25G Whitacre needle. The primary outcome of the study is to find out the difference in occurrence of Post dural puncture headache as a result of lumbar puncture with two differently engineered needles. Quincke needle tip is cutting bevelled type whereas Whitacre needle has a Non cutting pencil point tip.

The studies [8,9-11] concluded that the incidence and severity of post dural puncture headache was highest with 25G Quincke cutting needle compared with 25G Whitacre non cutting type of needle. In contrast to these studies the overall incidence of PDPH in our study is less (2.7%) vs 3-36.7%. But we also did not find any difference in incidence of PDPH because of two differently engineered tip needle.

Ranju Singh et al. (2009) [12] evaluated incidence of PDPH with 23G spinal Quincke needle in patients undergoing emergency caesarean section. They found that 34 patients out of 730 patients had typical PDPH, giving an incidence of 4.7%. A statistically significant association was found with incidence of PDPH and number of attempts, experience of anesthetist, position of patients, traumatic lumbar puncture. In our study also 2 patients out of total 74 patients (2.7%) in Quincke group developed post dural puncture headache and number of attempts in the both the patients were 4. In Whitacre group also 2 patients developed post dural puncture headache and number of attempts in 1 patient was 1 and in another patient it was 4. Our observed incidence of PDPH is 2.7% in each group. The lesser incidence of PDPH in our study is because of smaller needle size (25G) in contrast to the needle used by Ranju Singh et al. (23G).

N Ratan Singh and H Shanti Singh (2010) [13] found 3% PDPH rate in their study of 100 female patients undergoing lower abdominal surgery under spinal anesthesia using 25G Quincke needle. PDPH appeared mainly on 1st postoperative day and was associated with nausea and vomiting in one case and it disappeared by the 2nd and 3rd day following administration of mild analgesics and anti-emetics. In our study of 74 patients with 25G Quincke needle we observed incidence of 2.7% (n=2). Two patients from Quincke group had PDPH of which one patient complained PDPH along with neck stiffness.

In our study the number of attempts are similar to that of Siddharth P et al. with mean number of attempts 1.33 and 1.21 respectively for Quincke and Whitacre group of patients [14].

Frenkel C et al. (1992) [15] did a study on Two hundred and two male patients between 19 and 30 years of age with 25 guage spinal needle, they demonstated a PDPH rate of 3.5%. In contrast to Frenkel C et al. in our study incidence of hypotension and bradycardia was more in Quincke group (10.5% and 7%) which was no different from that of Whitacre group (10% and8%).

Hwang JJ et al. (1997) [16] prospectively observed 94 spinal anesthesias for cesarian section using the 25-gauge Whitacre needles and they concluded

that although the difference was not statistically significant, the 25-gauge Whitacre spinal needle caused a lower incidence and less severity of PDPH than the 25 gauge Quincke needles.

Fernandez R et al. (2003) [17] compared 27-gauge Whitacre needle and 27 gauge Quincke needle to assess the incidences of postdural puncture headache (PDPH) and puncture difficulty on 1,555 patients receiving spinal anesthesia for lower abdominal surgery and they concluded that, when a 27-gauge Whitacre-point needle is used, fewer cases of PDPH develop and the puncture is easier to accomplish than when a Quincke-point needle is used. This study is similar to our study except that we used a 25G needle of two differently designed tip to compare our outcomes (PDPH, number of attempts).

Knudsen et al. (1998) [18] studied on one hundred and six consecutive patients, aged below 40 years, Patients were allocated randomly to have spinal analgesia with either a Sprotte 24G or an Atraucan 26G spinal needle. Incidences of insufficient blocks were higher after dural puncture with the Atraucan needle. Nineteen patients reported post dural puncture headache (PDPH) with a significantly higher proportion of patients from Atraucan group [two patients suffered mild (4%) and 14 severe (98%) PDPH] compared to the Sprotte group [three patients suffered mild (6%) PDPH]. Eight patients (16%), from Atraucan group, required an epidural blood patch. Ease of needle insertion and number of puncture attempts were the same for both needles.

Handberg G et al. (1993) [19] studied on 100 patients aged 20-50 years assessed for PDPH after spinal anesthesia with the 25G Whitacre needle. None of the patients developed post-dural-puncture headache.

In a prospective study by Kreuscher H et al. (1989) [20] spinal anesthesia was performed in 500 patients and the study shows that the incidence of post spinal headache was significantly reduced by the use of Whitacre's pencil-point needle in comparison with findings reported in the literature.

Lynch J et al. (1992) [21] investigated in 400 patients and concluded that the 0.33 mm 29 gauge needle is associated with a low incidence of PDPH in young patients, but has a significantly higher failure rate than the Whitacre 0.7 mm needle, which is also a suitable choice in this age-group because of its ease of handling and the low incidence of PDPH.

In our study we used 25G Quincke needle with bevel parallel to the dural fibres and so did find a comparable incidence of PDPH in both the study groups (2.7%).

In an overview many studies do not agree that shape of the tip of needle affect the ease of puncture or first puncture success rate so long the size of the needle remain same. But most studies do agree that the size of the needle is a major determinant of PDPH.

However controversies surround regarding the incidence of PDPH when the needle size remains same but the tip of the needle is differently engineered. Few studies found no difference in occurrence of PDPH between a cutting (Quincke) and non-cutting pencil point needle (Whitacre).

The incidence, onset, resolution of PDPH in our study is similar to that of N Ratansingh and colleagues [13]. The number of attempts in our study is slightly more than a similar study conducted by Siddhartha P et al. [14] despite we used a 25G needle in contrast to 27G needle by Siddhartha P et al. [14] Though many studies reported increased technical difficulty with higher gauge needle (27G, 29G), the observed difference in our study is because all the intrathecal anesthesia.

Conclusion

Based on our study results we conclude that shape of the tip of the needle has no effect either on the number of attempts for a successful intrathecal anesthesia or on the incidence and severity of postdural puncture headache. However the overall incidence of post dural puncture headache is 2.7% and we did not observe any difference between 25G Quincke and 25G Whitacre needle on the incidence of PDPH (2.7% in both groups).

References

1. Cook TM, Counsell D, Wildsmith JA, Royal College of Anaesthetists Third National Audit Project. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. Br J Anaesth. 2009; 102:179–90.
2. Rodgers A, Walker N, Schug S. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results of overview of randomised trials. BMJ. 2000;321:1493–7.
3. Corning JL. A further contribution on local medication of the spinal cord, with cases. Med Rec. 1888;33:291–3.
4. Looseley A. Corning and cocaine: the advent of spinal anaesthesia. Grand Rounds. 2009;9.

5. Lavi R, Rowe JM, Avivi I. Lumbar puncture: it is time to change the needle. Eur Neurol. 2010; 64:108–13.
6. Angle PJ, Kronberg JE, Thompson DE, Ackerley C, Szalai JP, Duffin J. Dural tissue trauma and cerebrospinal fluid leak after epidural needle puncture: effect of needle design, angle, and bevel orientation. Anaesthesiology. 2003;99:1376–82.
7. Turnbull DK, Shepherd DM. Post-dural headache: pathogenesis, prevention and treatment. Br J Anaesth. 2003;91:718–29.
8. Buettner J, Wresch K-P, Klose R. Postdural puncture headache: comparison of 25 guage Whitacre and Quinke needle. Reg Anesth. 1993;18:166–9.
9. Pal A, Acharya A, Pal ND, Dawn S, Biswas J. Do pencil-point spinal needles decrease the incidence of postdural puncture headache in reality? A comparative study between pencil-point 25G Whitacre and cutting-beveled 25G Quincke spinal needles in 320 obstetric patients. Anesth Essays Res. 2011;5:162-6.
10. Baig T. Comparison of 25 Gauge Cutting with Noncutting Needles for Post Dural Puncture Headache in Obstetric Patients. J Anesth Clin Res.2014;5:448. Doi:10.4172/2155-6148.1000448.
11. Bano F, Haider S, Aftab S, Sultan ST. Comparison of 25-gauge, Quincke and Whitacre needles for postdural puncture headache in obstetric patients. J Coll Physicians Surg Pak. 2004;14:647-50.
12. Singh R, Padmaja S, Jain A. Incidence of post dural puncture headache with a 23G Quincke needle in emergency lower segment Caesarean section – an audit. J Anaesth Clin Pharmacol. 2009;25:486-90.
13. Singh NR, Singh HS. Postdural puncture headache: a study with 25G Quincke needle. J Indian Med Assoc. 2010;108:79-80.
14. Parmar S, Sheikh AN, Mankad P. 27G Quincke spinal needle for spinal anaesthesia in caesarean section: A study of 50 cases. Int J Med Sci Public Health. 2013;2:897-9.
15. Frenkel C, Altscher T, Groben V, Hornchen U. The incidence of post spinal headache in a group of young patients. Anaesthesist. 1992;41:142-5.
16. Hwang JJ, Ho ST, Wang JJ, Liu HS. Post dural puncture headache in cesarean section: comparison of 25-gauge Whitacre with 25- and 26-gauge Quincke needles. Acta Anaesthesiol Sin. 1997;35:33-7.
17. De Diego Fernandez R, Tisner Madrid ML, Cabrerizo Torrente P, Sanjoaquin Mur T. Comparison of two 27-G-caliber needles for spinal anaesthesia. Study of 1,555 patients. Rev Esp Anestesiol Reanim. 2003; 50:182-7.
18. Knudsen L, Dich-Nielsen JO, Molgaard O, Staach LJ, Rasmussen A, Rajan RM Atraucan, a new needle for spinal analgesia. Ugeskr Laeger. 1998;160:4636-9.
19. Handberg G, Skjelsager K, Christensen H, Marcus J. Spinal analgesia in young patients using the Whitacre needle G25. Ugeskr Laeger. 1993; 155:470-1.
20. Kreuscher H, Sandmann G. The relief of postspinal headache using the Whitacre cannula. A clinical study. Reg Anaesth. 1989;12:46-9.
21. Lynch J, Arhelger S, Krings-Ernst I. Post-dural puncture headache in young orthopaedic in-patients: comparison of a 0.33 mm (29-gauge) Quincke-type with a 0.7 mm (22-gauge) Whitacre spinal needle in 200 patients. Acta Anaesthesiol Scand. 1992; 36:58-61.