

To Compare the Incidence of Post-Dural Puncture Headache Using 25G Quincke and 25G Whitacre Spinal Needles in Patients Undergoing Lower Segment Caesarean Section

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ABSTRACT

BACKGROUND

Spinal anaesthesia is the first preference of anaesthesia in obstetric surgery. Post dural puncture headache (PDPH) is more common after C-section in young parturients. In the present world which is developing and fast-paced, brisk recovery along with minimal side effects & importantly early ambulation are now the need of the hour. This headache is more worrying to the mother who is required to tend to the newborn baby. This study compared the incidence of PDPH subsequent to sub-arachnoid blockade for lower segment Caesarean section (LSCS) 25G Whitacre & 25G Quincke needles. We wanted to compare the incidence of PDPH using 25G Quincke and 25G Whitacre spinal needles in patients undergoing LSCS.

METHODS

Two hundred (ASA II) American Society of Anaesthesiologists 11 females who were pregnant and in the age group of 20 - 50 years, planned to get sub-arachnoid blockade for C-section, were assigned randomly into two equal groups (N = 100 each). Both groups received spinal anaesthesia with 25-gauge Quincke and 25 gauge Whitacre needle. Postoperatively, incidence, site, onset, severity and duration of headache was studied.

RESULTS

The incidence of post spinal headache was 6 % in the Quincke group. No patients in Whitacre group had PDPH. The number of lumbar punctures required for successful sub arachnoid block was recorded in both the groups. 92 % patients from group Q and 88 % patients from group W required only one puncture. 8 % patients from group Q and 12 % patients from group W required two punctures.

CONCLUSIONS

It is prudent to conclude that 25G Whitacre spinal needle is a better alternative to 25G Quincke needle for reducing the incidence of post dural puncture headache in patients undergoing lower segment Caesarean section.

KEY WORDS

Spinal Anaesthesia, Post Dural Puncture Headache, Caesarean Section

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BACKGROUND

Spinal anaesthesia, also termed as sub-arachnoid block (SAB) or spinal analgesia, is a form of regional anaesthesia involving injection of a local anaesthetic into the cerebro-spinal fluid (CSF) through a spinal needle. Sub-arachnoid block is a commonly used practice by the anaesthesiologist worldwide.¹ Spinal anaesthesia dates back to late 19th century with the efforts of Quincke, Wynter and Corning.^{2,3} Nevertheless, Dr. Karl August Bier is credited for familiarising spinal anaesthesia into clinical practice in 1898.^{4,5}

The chief advantages of sub-arachnoid block are its simplicity, ease of performance, requirement of minimum apparatus, negligible effect on blood biochemistry, patient is awake maintaining a patent airway & post-operative analgesia. Nonetheless, sub-arachnoid block is not without complications. One of the troubling complications is post dural-puncture headache.⁶ Bier acquired first-hand experience of the incapacitating headache linked to dural-puncture. P.D.P.H. causes substantial morbidity, with symptoms lasting for quite a while, sometimes severe enough to bring to a halt the routine activities of the patients. It also increases the length of hospitalisation. In the present world which is developing and fast-paced, brisk recovery along with minimal side effects & importantly early ambulation are now the need of the hour.⁷ Moreover, it warrants a list of investigations to eliminate various causes of headache. This headache is more worrying to the mother who is required to tend for the newborn baby.

There are quite a few studies done regarding the measures for the reduction of P.D.P.H.^{8,9} It is thought that with the usage of finer gauge spinal needle & needle-tip modification, the incidence can be reduced to a better extent.^{10,11,12} Post dural puncture headache may also be linked to the design of the needle-tip and studies indicate that the dural spreading effect of pencil-point and conical-shaped needle tips is a significant determinant in reducing the loss of cerebro-spinal fluid after dural puncture, thus, reducing the incidence of P.D.P.H.^{13,14, 15,16} The Quincke needle is the most popular and widely used spinal needle among anaesthesiologists. Hence, we proposed to compare the incidence and the severity of P.D.P.H. in obstetric females using 25-gauge Quincke spinal needle and 25-gauge Whitacre spinal needle.

METHODS

This was a prospective, comparative interventional study for evaluating the incidence of post-dural puncture headache using 25G Quincke and 25G Whitacre spinal needles in patients undergoing lower segment Caesarean section under spinal anaesthesia. After obtaining approval from the institutional ethics committee & written informed consent from all the patients, this study was conducted in the Department of Anaesthesiology, Acharya Vinoba Bhave Rural Hospital, affiliated to Jawaharlal Nehru Medical College, DMIMS Sawangi (Meghe) Wardha, between August 2018 to August 2020 on 200 obstetric patients.

Sample Size for Frequency in a Population

- Population size (for finite population correction factor or fpc) (N) – 200000
- Hypothesised % frequency of outcome factor in the population (p) – 8 % + / - 5
- Confidence limits as % of 100 (absolute + / - %) (d) – 5 %
- Design effect (for cluster surveys - DEFF)

Sample Size (n) for Various Confidence Levels

Confidence Level (%)	Sample Size
95 %	114
80 %	49
90 %	80
97 %	139
99 %	196
99.9 %	319
99.99 %	445

Table 1. Sample Size for Various Confidence Intervals

Equation

- Sample size $n = [DEFF * Np (1 - p)] / [d^2 / Z^2_{1-\alpha/2} * (N - 1 + p * (1 - p))]$
- Results from Open Epi, Version 3, open source calculator – SSPropor
- Print from the browser with ctrl – P
- Or select text to copy and paste to other programs.

Sample size calculation was performed using OpenEpi.com. Assuming incidence of postdural puncture headache as 8 % as per the study conducted by Shaikh et al. (53), confidence intervals at 99 %, a sample of 196 patients would be required. We included total 2 patients in each group to compensate for possible dropouts.

Inclusion Criteria

- Patients willing to participate in the study.
- Age: 18 - 50 years antenatal care (ANC) patients undergoing LSCS.
- Weight: 40 - 80 kg.
- ASA class I and II patients.

Exclusion Criteria

- Patients not willing to participate in the study.
- Age: < 20 and > 50 years.
- Weight: < 40 or > 80 kg.
- ASA class - III and above.
- If spinal anaesthesia is converted to general anaesthesia due to prolonged surgery.
- Patients with prior history of headache.
- Infection at the site of spinal anaesthesia.
- Patients with haemorrhagic diathesis.
- Any other contraindications to spinal anaesthesia

200 patients who fulfilled all the inclusion criteria were equally divided into two groups of 100 each randomly by computer generated random number table & allocation of the same in sealed envelope technique:

- Group Q (Quinke) - Received sub arachnoid block with 25G Quinke needle.
- Group W (Whitacre) – Received sub arachnoid block with 25G Whitacre needle.

Prior to surgery pre-anaesthetic check-up was performed for all the patients. After taking a detailed history, thorough general & systemic examination was done to rule out respiratory, cardiovascular, neurological and any associated problems. All routine investigations i.e. complete blood count (CBC), liver function test (LFT), kidney function test (KFT), coagulation profile and electrocardiograph (ECG) of the patients were done and recorded. Weight of all the patients in the study was also recorded. Written informed consent was obtained from all the patients before the surgery. Local anaesthetic sensitivity testing was performed on all patients prior to surgery.

On arrival in the operation theatre, multipara monitor was connected to the patients and vitals such as pulse rate (PR), mean arterial pressure (MAP), percentage saturation of oxygen (SpO₂), respiratory rate (RR) and electrocardiograph were recorded and monitored throughout the surgery. An intravenous access was obtained in the upper limb using 18G intravenous cannula. Intravenous infusion of crystalloids like Ringers' lactate / normal saline was initiated @ 10 ml / kg initially to correct the deficit followed by maintenance of 2 ml / kg. injection ondansetron 4 mg iv was given.

Under all aseptic precautions, spinal anaesthesia was given with injection bupivacaine 0.5 % (heavy) 2 ml in the sitting position using a 25-gauge Quinke or 25-gauge Whitacre spinal needle (as per the group allotted) positioned at the L3 - L4 interspace. Patients were immediately turned to the supine position.

Onset of sensory anaesthesia was checked with pin prick, and motor block assessment was carried out with Bromage scale.¹⁷ Adequate height of block was achieved (T4 or T6) and the surgery was allowed after recording the final height of block.

Postoperative Period

Patients were monitored in the wards for any post-operative complications and were treated with appropriate measures for a minimum of 72 hours.

The following parameters were recorded and compared between both the groups:

- Punctures required for successful SAB.
- Appreciation of anatomical layers while giving SAB.
- The time taken for CSF to reach the needle hub.
- PDPH – onset, duration, site and severity.
- Nausea & vomiting (if any).
- Treatment given for management of PDPH.

Criteria for PDPH¹⁸

- Arose after mobilisation.
 - Aggravated by sitting / erect position & sneezing coughing / straining.
 - Relieved by laying supine.
 - Typically localised in occipital, frontal or generalised.
- Other types of headache were excluded from study.

The patients with features suggestive of PDPH were treated with iv fluids, bed rest, caffeine intake and iv paracetamol 15 mgs / kg, three times a day.

The severity of headache was categorised as follows:¹⁸

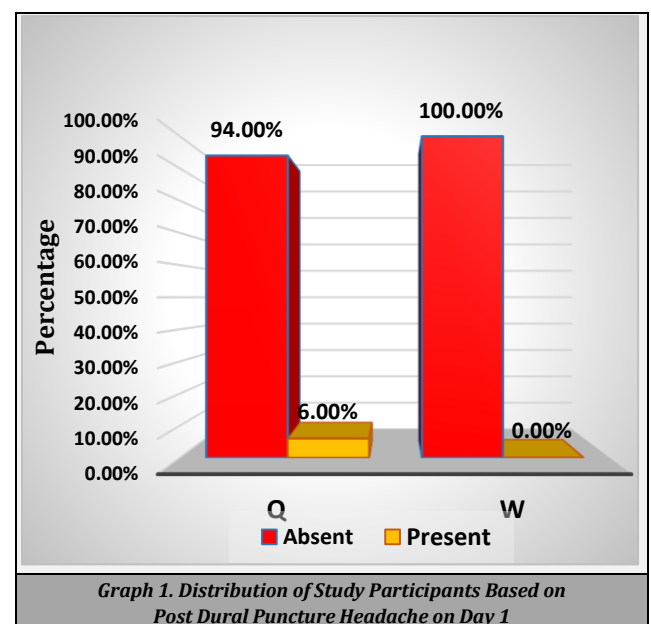
- Mild P.D.P.H.
- Minor limitation of physical activity. Such patients were not restricted to bed & had no associated symptoms.
- Moderate P.D.P.H. The patient had to stay in the bed for part of the day, which lead to limited physical activity & not essentially associated with symptoms.
- Severe P.D.P.H.

The patients were confined to bed for most of the day and accompanying symptoms were always present.

Statistical Analysis

All the data was entered in the Microsoft Excel. All qualitative data was expressed as percentage & the quantitative data were expressed as mean ± standard deviation. Qualitative data was analysed by using chi-square test & quantitative data was analysed by using Student t-test. Software used in the analysis were SPSS 20.0 version & Graph Pad Prism 6.0 version & P < 0.05 was considered statistically significant.

RESULTS



Graph 1 shows the incidence of post dural puncture headache on day 1 in both the groups. 6 patients (6 %) had PDPH on day 1 in group Q. No patients (0 %) had PDPH in group W. The difference between the two groups was statistically significant (P = 0.014)

Graph 2 shows the incidence of post dural puncture headache on day 2 in both the groups. 2 patients (2 %) had PDPH persistent on day 2 in group Q. No patients (0 %) had PDPH in group W. The difference between the two groups was not statistically significant (P = 0.249)

Graph 3 shows the site of headache in patients in both the groups. 2 patients (2 %) had frontal headache and 4 patients (4 %) had occipito-frontal headache from group Q. No patients

had headache in group W in our study. There was statistically significant difference between the two groups (P = 0.014)

DISCUSSION

Parameters Monitored in Patients of Each Group

Demographic Data

The incidence of PDPH is more common among females than males, particularly prone are the parturient population,^{19,20} due to the decrease of both the intra-abdominal & epidural pressure after the delivery, thus causing additional leakage of C.S.F. Gender bound variance is due to hormonal & emotional factors. In our study, we have preferred to choose female patients because women report more pain as compared to men, and have a lower pain threshold & tolerance to painful stimulus.^{21,22} The reasons that are responsible for higher incidence of P.D.P.H. in obstetric patients include changing hormonal level, stress of labour & dehydration. Due to these reasons, this study was conducted only in cases of Caesarean section.^{23,24,25} The difference between the two groups was not statistically significant. (P = 0.882). The patients were comparable with respect to age. The patients were comparable in both the groups with respect to weight as the difference was statistically non-significant. (P = 0.902)

Number of Punctures Required

Maximum number of patients i.e. 92 % from group Q and 88 % from group W in our study required only one puncture. 8 % patients from group Q and 12 % patients from group W in our study required two punctures. The difference between the two groups was not statistically significant. (P = 0.348), hence the patients were comparable. The present study is comparable to the results of the study by Shutt LE et al. who studied the ease of insertion of 22-gauge Whitacre needle and 25 gauge Whitacre.^{26,27} The present study is also comparable with the results of Emad Lotfy Mohammed et al. who studied efficacy of different size Quincke spinal needles in reduction of incidence of PDPH in Caesarean section and found that the difference in number of attempts to reach sub-arachnoid space was not significant statistically.⁶

Incidence of Post Dural Puncture Headache

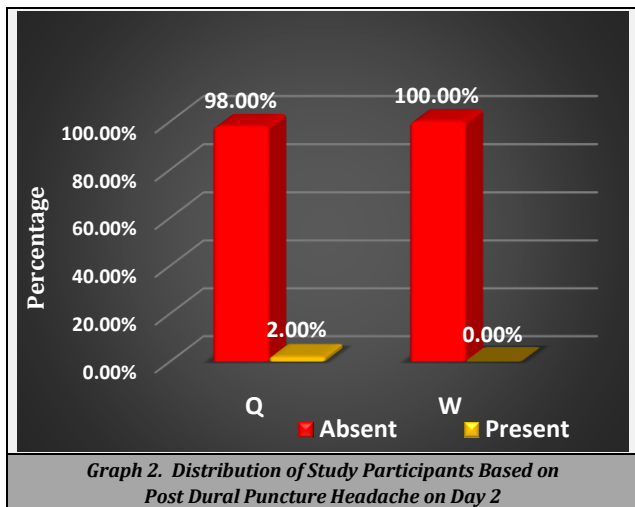
Table 1. Graph 1

Illustrates the incidence of postdural puncture headache on day 1 in both the groups. 6 patients (6 %) had PDPH on day 1 in group Q. No patients had PDPH in group W. The difference between the two groups was statistically significant (P = 0.014)

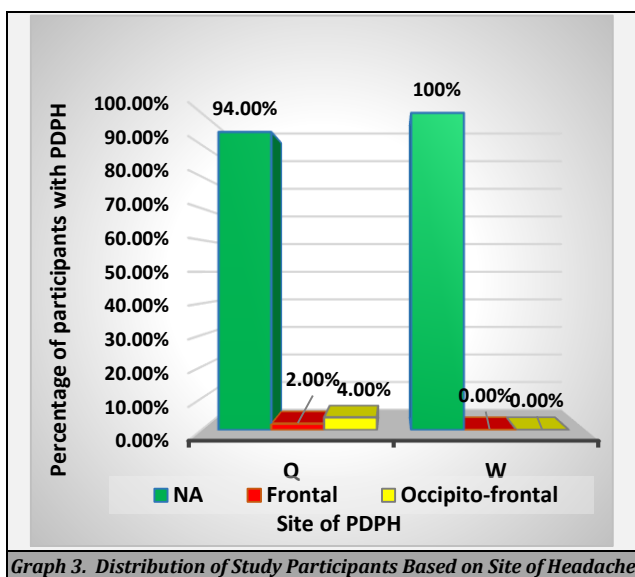
Graph 2

Shows the incidence of post dural puncture headache on day 2 in both the groups. 2 patients (2 %) had PDPH persistent on day 2 in group Q. No patients had PDPH in group W. The difference between the two groups was not statistically significant (P = 0.249). No patients had PDPH in group Q and group W.

Mayer et al. in his study found that there was no statistically significant difference between Quincke & Sprotte spinal needles. But the study showed marked reduction in headache when Whitacre needle was used.^{1,28} Vallejo et al. conducted a study in 1002 obstetrical patients, using five types

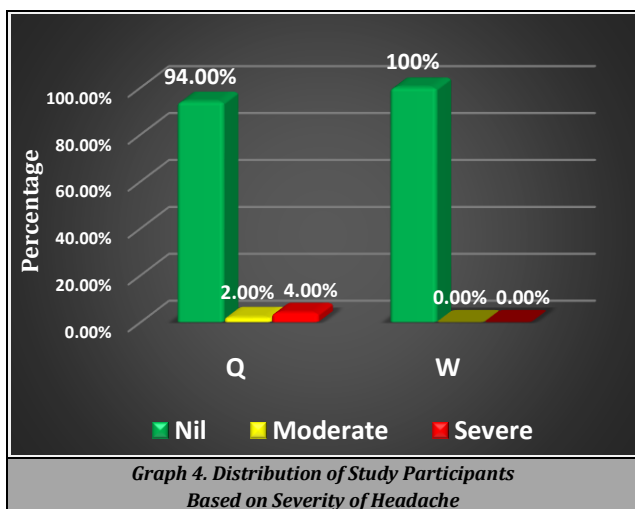


Graph 2. Distribution of Study Participants Based on Post Dural Puncture Headache on Day 2



Graph 3. Distribution of Study Participants Based on Site of Headache

Graph 4 shows the severity of headache in patients of both the groups. 2 patients (2 %) had moderate headache and 4 patients (4 %) had severe headache from group Q. No patients had headache in group W in our study. There was statistically significant difference between the two groups (P = 0.014)



Graph 4. Distribution of Study Participants Based on Severity of Headache

of spinal needles and showed a lower incidence & severity of P.D.P.H. with 25-gauge Whitacre needle.¹¹ In a study conducted by Campbell et al. in 300 patients, a P.D.P.H incidence of 0.66 per cent (1 per 150) after using 25G Whitacre spinal needle was demonstrated.^{29,30}

The present study is comparable to study done by Wiesel. S et al. They had compared 24G Sprotte and 27G Quincke needle in young patients. The incidence of PDPH with the 27G Quincke needle is 12.8 % whereas in the present study it is 6 %.^{31,32} The present study is compared to a study done by Santanen U et al. They compared 27 Gauge Whitacre with 27 Gauge Quincke needle with respect to PDPH and NPDPH. The incidence of post dural puncture headache in the Quincke group is 2.7 % whereas with the Whitacre needle it is 0.3 %.^{33,34}

The present study is comparable to a prospective randomised study and a meta-analysis, done by Flaatten H. et al. They compared the incidence of PDPH, in 27 Gauge Quincke with 27 Gauge Pencan needle. 27 Gauge Quincke needle had 8 % PDPH and 27G Pencan needle had 1.9 %.^{35,36} It is comparable to study done by Corbey M.P. et al. The team compared the incidence of PDPH in 27-gauge Quincke with 26-gauge Quincke. In their study, 27-gauge Quincke had 8 % PDPH which is comparable to the present study.^{37,38} Bano F et al. in their study involving 100 females observed an incidence of 0.75 % with 25-G Whitacre needle.³⁹

Site of Headache

Graph 3

Shows the site of headache in patients of both the groups. 2 patients (2 %) had frontal headache and 4 patients (4 %) had occipito-frontal headache from group Q. No patients had headache in group W in our study. There was a statistically significant difference between the two groups ($P = 0.014$). Regarding the onset, location, the present study is comparable to study by Shah A. et al. In their study location was frontal in 7 cases and generalised in 2 cases.²³

Severity of Headache

Graph 4

Shows the severity of headache in patients of both the groups. 2 patients (2 %) had moderate headache and 4 patients (4 %) had severe headache from group Q. No patients had headache in group W in our study. There was a statistically significant difference between the two groups ($P = 0.014$)

The duration lasted for 24 hours in four patients and 48 hours in two patients in Quincke group. No patients had headache in group W in our study. Regarding the severity and duration of headache, the present study is comparable to study by Shah A. et al. In their study, the headache was mild in all cases and duration less than 24 hours in all cases except 1 patient who had headache for 48 hours.²³

The present study is comparable with the findings of Emad Lotfy Mohammed et al. who studied efficacy of different size Quincke spinal needles in reduction of incidence of PDPH in Caesarean section and found that the onset of PDPH in their study was in the range of 6 to 48 hrs. in the two groups.

Treatment modalities for post dural puncture headache include simple measures such as non-steroidal anti-inflammatory drugs (NSAIDs) & optimising hydration status to

complex procedures as epidural blood patch. Simple measures are very effective in managing majority of the cases of P.D.P.H. In our study, optimising hydration, NSAIDs & adequate rest relieved headache in patients.

CONCLUSIONS

25G Whitacre spinal needle is a better alternative to 25G Quincke needle for reducing the incidence of post dural puncture headache in patients undergoing lower segment Caesarean section, as it has good appreciation of anatomical layers with comparable profile than Quincke needle.

We recommend usage of 25G Whitacre spinal needle to be included in the routine protocol for spinal anaesthesia in patients undergoing lower segment Caesarean section under spinal anaesthesia. We recommend the use of our study data as baseline data to other researchers.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

Disclosure forms provided by the authors are available with the full text of this article at jemds.com.

REFERENCES

- [1] Mayer DC, Quance D, Weeks SK. Headache after spinal anaesthesia for cesarean section: a comparison of the 27-gauge Quincke and 24-gauge Sprotte needles. *Anesth Analg* 1992;75(3):377-80.
- [2] Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. *Br J Anaesth* 2003;91(5):718-29.
- [3] Looseley A. Corning and cocaine: the advent of spinal anaesthesia. *Grand Rounds* 2009;9:L1-4.
- [4] Calthorpe N. The history of spinal needles: getting to the point. *Anaesthesia* 2004;59(12):1231-41.
- [5] Marx GF. The first spinal anaesthesia. Who deserves the laurels? *Reg Anesth* 1994;19(6):429-30.
- [6] Mohammad EL, El Shal SM. Efficacy of different size Quincke spinal needles in reduction of incidence of Post-Dural Puncture Headache (PDPH) in Caesarean Section (CS). *Randomized controlled study. Egyptian Journal of Anaesthesia* 2017;33(1):53-8.
- [7] Atkinson RS, Rushman GB, Davies NAH. Lee's synopsis of anaesthesia. 11th edn. Oxford: Butterworth Heinemann 1993.
- [8] Kleyweg RP, Hertzberger LI, Carbaat PA. Significant reduction in post-lumbar puncture headache using an atraumatic needle. A double-blind, controlled clinical trial. *Cephalalgia* 1998;18(9):635-7.
- [9] Vidoni ED, Morris JK, Raider K, et al. Reducing post-lumbar puncture headaches with small bore atraumatic needles. *J Clin Neurosci* 2014;21(3):536-7.
- [10] Abdullayev R, Celik B, Hatipoglu S, et al. Incidence of postdural puncture headache: Two different fine gauge spinal needles of the same diameter. *J Obstet Anaesth Crit Care* 2014;4(2):64-8.
- [11] Vallejo MC, Mandell GL, Sabo DP, et al. Postdural puncture headache: a randomized comparison of five spinal

- needles in obstetric patients. *Anesth Analg* 2000;91(4):916-20.
- [12] Krommendijk EJ, Verheijen R, Van Dijk B, et al. The PENCAN 25-gauge needle: a new pencil-point needle for spinal anaesthesia tested in 1,193 patients. *Reg Anesth Pain Med* 1999;24(1):43-50.
- [13] 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(1):58-61.
- [14] Tetzlaff JE. Cousins and Bridenbaugh's neural blockade in clinical anaesthesia and pain medicine. *Mayo Clin Proc* 2010;85(7):e51.
- [15] Kalra P. Miller's anaesthesia. Vol. 1 & 2. 7th edn. *Anesthesiology* 2010;112(1):260-1.
- [16] Dyer A. Barash clinical anaesthesia. [cited 2020 Nov 5] https://www.academia.edu/33839068/Barash_Clinical_Anesthesia
- [17] Wulf HF. The centennial of spinal anaesthesia. *Anesthesiology* 1998;89(2):500-6.
- [18] Bromage PR. A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. *Acta Anaesthesiol Scand Suppl* 1965;16:55-69.
- [19] Raskin NH. Lumbar puncture headache: a review. *Headache* 1990;30(4):197-200.
- [20] Greene HM. Lumbar puncture and the prevention of post-puncture headache. *J Am Med Assoc* 1926;86(6):391-2.
- [21] Hart JR, Whitacre RJ. Pencil-point needle in prevention of postspinal headache. *J Am Med Assoc* 1951;147(7):657-8.
- [22] Wise EA, Price DD, Myers CD, et al. Gender role expectations of pain: relationship to experimental pain perception. *Pain* 2002;96(3):335-42.
- [23] Dittman M, Schafer HG, Ulrich J, et al. Anatomical re-evaluation of lumbar dura mater with regard to postspinal headache. Effect of dural puncture. *Anaesthesia* 1988;43(8):635-7.
- [24] Corbey MP, Bach AB, Lech K, et al. Grading of severity of postdural puncture headache after 27-gauge Quincke and whitacre needles. *Acta Anaesthesiol Scand* 1997;41(6):779-84.
- [25] Lambert D, Hurley R, Hertwig L, et al. Role of needle gauge and tip configuration in the production of lumbar puncture headache. *Reg Anesth Pain Med* 1997;22(1):66-72.
- [26] Dittmann M, Schaefer HG, Renkl F, et al. Spinal anaesthesia with 29 gauge Quincke point needles and post dural puncture headache in 2,378 patients. *Acta Anaesthesiol Scand* 1994;38(7):691-3.
- [27] Shutt LE, Valentine SJ, Wee MYK, et al. Spinal anaesthesia for Caesarean section: comparison of 22-gauge and 25-gauge whitacre needles with 26-gauge quincke needles. *Br J Anaesth* 1992;69(6):589-94.
- [28] Ross BK, Chadwick HS, Mancuso JJ, et al. Sprotte needle for obstetric anaesthesia: decreased incidence of post dural puncture headache Regional anaesthesia. 1992;17(1):29-33.
- [29] Lybecker H, Moller JT, May O, et al. Incidence and prediction of postdural puncture headache. A prospective study of 1021 spinal anaesthesias. *Anesth Analg* 1990;70(4):389-94.
- [30] Buettner J, Wresch KP, Klose R. Postdural puncture headache: comparison of 25-gauge whitacre and quincke needles. *Reg Anesth* 1993;18(3):166-9.
- [31] Flaatten H, Felthaus J, Kuwelker M, et al. Postural post-dural puncture headache. A prospective randomised study and a meta-analysis comparing two different 0.40 mm O.D. (27 g) spinal needles. *Acta Anaesthesiol Scand* 2000;44(6):643-7.
- [32] Wiesel S, Tessler MJ, Easdown LJ. Postdural puncture headache: a randomized prospective comparison of the 24 gauge Sprotte and the 27 gauge Quincke needles in young patients. *Can J Anaesth* 1993;40(7):607-11.
- [33] Best Evidence Anaesthesia Reports (BEARs). *Indian Journal of Anaesthesia*. [cited 2020 Nov 5]. <https://www.ijaweb.org/downloadpdf.asp?issn=0019-5049;year=2006;volume=50;issue=4;spage=307;epage=307;aulast=Kotur;type=0;type=2>
- [34] Douglas MJ, Ward ME, Campbell DC, et al. Factors involved in the incidence of post-dural puncture headache with the 25 gauge Whitacre needle for obstetric anaesthesia. *Int J Obstet Anesth* 1997;6(4):220-3.
- [35] Eriksson AL, Hallen B, Lagerkranser M, et al. Whitacre or Quincke needles--does it really matter. *Acta Anaesthesiol Scand Suppl* 1998;113:17-20.
- [36] Halpern S, Preston R. Postdural puncture headache and spinal needle design. Metaanalyses. *Anesthesiology* 1994;81(6):1376-83.
- [37] Cruickshank RH, Hopkinson JM. Fluid flow through dural puncture sites. An in vitro comparison of needle point types. *Anaesthesia* 1989;44(5):415-8.
- [38] Peterman SB. Postmyelography headache rates with Whitacre versus Quincke 22-gauge spinal needles. *Radiology* 1996;200(3):771-8.
- [39] Dahl JB, Schultz P, Anker-Møller E, et al. Spinal anaesthesia in young patients using a 29-gauge needle: technical considerations and an evaluation of postoperative complaints compared with general anaesthesia. *Br J Anaesth* 1990;64(2):178-82.