PERIODICUM BIOLOGORUM
VOL. 115, No 2, 203–208, 2013

UDC 57:61
CODEN PDBIAD
ISSN 0031-5362

Original research paper

Incidence and clinical significance of post-dural puncture headache in young orthopaedic patients and parturients

DAGMAR OBERHOFER
ALEKSANDRA JOKIĆ
IRA SKOK
JADRANKA SKURIĆ
MILKA VUKELIĆ
IVAN ŠKLEBAR
DINKO TONKOVIĆ

Department of Anaesthesiology, Reanimatology and Intensive Care
University Hospital Sveti Duh
Sveti Duh 64, 10000 Zagreb

Correspondence:
Dagmar Oberhofer, MD. PhD.
Department of Anaesthesiology, Reanimatology and Intensive Care
University Hospital Sveti Duh
Sveti Duh 64, 10000 Zagreb
E-mail: dagmar.oberhofer@zg.htnet.hr

Abbreviations:
BMI – body mass index
CSF – cerebrospinal fluid
Non-PDPH – non-postdural puncture headache
PDPH – post-dural puncture headache

Received May 20, 2013.

Abstract

Background and Aims: *Post-dural puncture headache (PDPH) is a complication of spinal anaesthesia, influenced mostly by patient's age, spinal needle size and design and, possibly, female gender. The purpose of this prospective observational study was to compare the frequency and clinical significance of PDPH in two patient groups at high risk for the development of PDPH, namely young parturients and orthopaedic patients, using 26-G and 27-G Quincke needles.*

Patients and Methods: *The study included 56 parturients undergoing Caesarean section and 59 orthopaedic patients undergoing arthroscopic knee surgery, who received standard spinal anaesthesia using 26-G or 27-G Quincke needles. All patients were less than 40 years of age. The patients were visited on postoperative days 1, 2, and 4 or contacted by telephone and evaluated for the presence, characteristics and severity of headache, backache and other possible complications. Only posture dependent headache was regarded as PDPH with severity graded as mild, moderate and severe. Patient satisfaction was assessed by their willingness to have spinal anaesthesia in the future.*

Results: *Orthopaedic patients were predominantly male (81.4%) and significantly younger than parturients (27.8±5.5 vs. 33.7±4.7 years, $P<0.0001$). Both groups had similar use of 26-G and 27-G needles, one attempt success rate at dural puncture, and high quality of spinal block. The incidence of PDPH in parturients was 14.3% and in orthopaedic patients 13.6%, which was not significantly different. Also, the severity of PDPH was similar, with mild headache in four out of eight PDPH patients in each group. The rate was similar with 26-G and 27-G needles. No patient required an epidural blood patch. Both orthopaedic patients and parturients expressed high satisfaction rate with spinal anaesthesia (96.6% and 94.6%, respectively).*

Conclusion: *The rate of PDPH was similar in young orthopaedic patients and parturients but higher than in the literature. Low rate of severe headache, no need for epidural blood patch, and high patient satisfaction with spinal anaesthesia, make 26-G and 27-G Quincke needles an acceptable technique where pencil point needles are not available.*

INTRODUCTION

Post-dural puncture headache (PDPH) is the most common complication of spinal anaesthesia, which can cause significant patient discomfort and disability. It was first described in 1898 when the first successful spinal anaesthesia was performed *(1)*. Since then numerous

studies have been published on its pathophysiology, incidence, prevention and treatment. The most important factors influencing the frequency and severity of PDPH are the patient's age, spinal needle size and bevel design *(2)*. The incidence and severity of PDPH is progressively reduced when smaller size Quincke-type (cutting) spinal needles are used. This can be further reduced with noncutting, pencil-point spinal needles (Whitacre, Sprotte), without increasing the risk of the procedure failure *(3, 4)*. Female gender has also been linked to PDPH. Although earlier studies included mainly parturients where young age could be a confounding factor, more recent systematic review found that nonpregnant females also had a higher risk of PDPH than males *(5)*. Because of young age and gender obstetrical patients, who frequently receive epidural and spinal anaesthesia for labour and delivery, are considered the highest risk group for PDPH *(6)*. This has been extensively investigated in the literature with reported frequency of PDPH of 5.2–5.6% with 26-gauge Quincke needles, 2.7–2.9% with 27-gauge Quincke needles and 1.2–1.7% with Whitacre 25 and 27-gauge needles *(6, 7)*. Another high risk group are young orthopaedic patients undergoing ambulatory or short hospital stay surgery. Regional anaesthesia, especially combination of spinal anaesthesia with periferal nerve blocks has gained popularity for lower extremity surgery because of better postoperative analgesia and mobilisation. However, there is not much data on the incidence and severity of PDPH with the use of smaller diameter Quincke and/or pencil point needles in these patients. Reports on PDPH in ambulatory surgery patients included patients of different age groups undergoing various surgical procedures *(4, 8)*. Besides, the incidence of PDPH in young ambulatory surgery patients differed significantly between the studies even for 27-G needles *(9, 10)*.

The aim of this prospective observational study was to compare the frequency and clinical significance of PDPH in two patient groups at high risk for the development of PDPH, namely parturients and young orthopaedic patients, using 26-G and 27-G Quincke needles. Clinical significance of headache was judged by its severity, the need for treatment with epidural blood patch and patient acceptance of spinal anaesthesia for future procedures.

PATIENTS AND METHODS

This prospective observational study included parturients undergoing elective or emergency Caesarean section and young orthopaedic patients scheduled for lower extremity surgery during the three month period (December 2012–March 2013) at the University Hospital Sveti Duh in Zagreb. The study protocol was approved by the Hospital Ethics Committee and informed consent was obtained from the patients. The study included patients 18–40 years of age undergoing surgery under spinal anaesthesia using 26-G and 27-G Quincke needles (Becton Dickinson, Spain). Patients in whom spinal block was performed with a different type of spinal needle (Quincke 25-G or Whitacre 25-G), either as the first choice or after unsuccessful trial with 26-G or 27-G Quincke needles, were not included. All patients were evaluated by an anaesthesiologist preoperatively and the history of headache was recorded. Patients received no premedication on the day of surgery. On arrival to the preoperative area intravenous infusion of crystaloid solution was started and the time from the last fluid intake was recorded. After checking vital signs orthopaedic patients were given midazoloam 2–3 mg i.v. for the relief of anxiety, if necessary. Obstetrical patients were preloaded with 15 ml/kg and orthopaedic patients with 10 ml/kg of crystaloid prior to initiation of the subarachnoid block. Routine intraoperative monitoring included continuous ECG, automated blood pressure measurements every 5 minutes and pulse oxymetry. Lumbar puncture was performed with the patient in the sitting position using a midline approach at the L3–L4 or L4–L5 intervertebral space. The bevel of the spinal needle was kept parallel to the longitudinal axis of the dural fibers. If midline lumbar puncture was unsuccessful, paramedian approach could be used. After return of clear cerebrospinal fluid 12–15 mg of 5 mg/ml levobupivacaine solution (5 mg/ml Chirocaine, Abbott S.R.L., Italy) was injected over 10–15 seconds. In parturients the solution was made hyperbaric with the addition of 0.4 ml of 40% glucose, while in orthopaedic patients 0.5% isobaric or hyperbaric levobupivacaine solution was used. Intraoperatively, we recorded the number of attempts for successful dural puncture and adequacy of spinal block for the surgical procedure (any requirement for intraoperative analgesic supplement or failed spinal requiring conversion to general anaesthesia). Patients were encouraged to mobilize early postoperatively, which was also dependent on the surgical procedure and uncomplicated postoperative course. The time to sitting and standing/walking was recorded.

Postoperatively, patients were visited on day 1, 2, and 4 and questioned about the presence, severity and characteristics of the headache, backache and symptoms possibly associated with PDPH like nausea, vomiting, neck stiffness and auditory or ocular disturbances. Patients who were discharged before postoperative day 4, which was the case with the majority of orthopaedic patients, were contacted via telephone interview. On postoperative day 4 patients were asked about their satisfaction with the anaesthetic technique. Specifically, they were asked if they would accept spinal anaesthesia for a similar surgical procedure in the future. PDPH was defined as a posture dependent headache, mainly frontal or occipital which was brought on or aggravated by erect posture and relieved or improved by lying down. The severity of PDPH was graded as mild, moderate or severe *(11)*. Mild PDPH caused no interference with daily activities and required no treatment. Moderate PDPH caused a patient difficulty in performing daily activities and was treated with oral analgesics. Patients with severe PDPH were unable to perform their daily activities, were confined to bed and required regular oral/i.v. analgesics and/or epidural blood patch for treatment. In patients who developed PDPH, treatment included bed rest, enhanced

fluid intake (per os and i.v.), oral and i.v. analgesics (paracetamol, non-steroidal antiinflammatory drugs) and caffeine. Patients with severe PDPH refractory to treatment were offered an epidural blood patch.

Statistical analysis was performed using SPSS software for Windows, version 9.0 (SPSS Inc., Chicago, IL, USA). Categorical data were presented as numbers (frequences), while numerical data were presented as mean ± SD. Chi-square test was used to compare categorical variables and Student's t-test was used to compare numerical variables between the groups. A P value < 0.05 was considered significant.

RESULTS

Fifty six parturients undergoing elective or emergency Caesarean section and 59 patients undergoing arthroscopic knee surgery, all younger than 40 years of age, were enrolled. The majority of orthopaedic patients had anterior cruciate ligament repair (57 patients) and two patients underwent arthroscopy and partial meniscectomy. No patient was excluded after entering the study. Preoperative characteristics of patients are presented in Table 1. Orthopaedic patients were predominantly male (81.4%) and significantly younger than parturients (27.8 ± 5.5 years and 33.7 ± 4.7 years, respectively, P < 0.0001) who also had more frequent history of headaches and shorter preoperative fasting times. The characteristics of the spinal block are summarized in Table 2. Both groups had similar use of 26-G and 27-G Quincke needles, which was slightly more in favour of 26-G needles (52.5% in orthopaedic patients and 57.1% in parturiens). There were no differences between the groups in one attempt success rate at dural puncture, number of attempts needed to obtain CSF or quality of spinal blockade. Only one parturient received a general anaesthesia because of incomplete block.

TABLE 1

Patient characteristics.

	Orthopaedic (n=59)	Parturients (n=56)	P value*
Sex (F:M)	9:48	n.a.	n.a.
Age (years)	27.8±5.5	33.7±4.7	P < 0.0001
Weight (kg)	81.2±13.6	80.2±12.6	P = 0.6835
Height (cm)	180.4±8.5	166.8±6.6	P < 0.0001
BMI (kg/m^2)	24.74±2.77	28.69±4.19	P < 0.0001
History of headache	8 (13.6%)	22 (39.3%)	P = 0.0017**
Fasting (hours)	13.0±4.5	9.3±3.5	P < 0.0001

*t- test, except as indicated; **Chi-square test
Values are mean ± SD or number (proportion); n.a.= not applicable; BMI = body mass index

The incidence of PDPH was similar in orthopaedic patients (13.6%) and parturients (14.3%), as was the total number of days that PDPH was experienced among all patients in each group (Table 3). The severity of headache was graded as mild in four out of eight orthopaedic patients with PDPH and in four out of eight parturients with PDPH. No patient required an epidural blood patch. The frequency of non-postduralpuncture headache (non-PDPH) was low in both groups. Postoperative backache was more common in parturients, while nausea and vomitting were significantly more common in orthopaedic patients. No major complications related to spinal anaesthesia occured.

We found no association of PDPH with patient's age, body mass index (BMI), history of headache, preopera-

TABLE 2

Spinal block characteristics in orthopaedic patients and parturients.

	Orthopaedic (n=59)	Parturients (n=56)	P value*
Spinal needle size			
26-G Quincke	31 (52.5%)	32 (57.1%)	P = 0.6203
27-G Quincke	28 (47.5%)	24 (42.9%)	P = 0.6203
Success with one attempt	43 (72.9%)	39 (69.6%)	P = 0.7012
No. of attempts to obtain CSF			
1	43 (72.9%)	39 (69.6%)	P = 0.925
2	12 (20.3%)	13 (23.2%)	
3 or more	4 (6.8%)	4 (7.1%)	
Quality of spinal blockade			
Adequate	55 (93.2%)	53 (94.6%)	P = 0.4615
Minor supplements	4 (6.8%)	2 (3.6%)	
Failed	0	1 (1.8%)	
Patient satisfaction†	57 (96.6%)	53 (94.6%)	P = 0.267

Values are number (proportion); †patient would accept spinal technique for future procedures
*Chi-square test

TABLE 3

Comparison of complications between orthopaedic patients and parturients.

	Orthopaedic (n=59)	Parturients (n=56)	P value*
PDPH			
Frequency	8 (13.8%)	8 (14.3%)	0.9104
Severity (mild/moderate/severe)	4/2/2	4/3/1	n.a.
Duration (days)	17	20	0.4965
Non-PDPH	2 (3.4%)	4 (7.1%)	0.3657
Nausea/vomiting	5 (8.5%)	0	0.0259
Backache	5 (8.5%)	11 (19.6%)	0.0837

Values are number (proportion) of patients with specific complications
PDPH = post-dural puncture headache; Non-PDPH = headache other then PDPH
*Chi-square test; n.a.= not aplicable due to small number of patients

TABLE 4

Patient and spinal procedure data with regard to the development of PDPH in **orthopaedic** patients.

	PDPH (n=8)	No PDPH (n=51)	P value*
Age (years)	25.6±4.5	28.1±5.6	0.2346**
Female gender	2 (25%)	7 (13.7%)	0.4096
BMI (kg/m^2)	23.95±2.92	24.89±2.73	0.3736**
History of headache	2 (25%)	6 (11.8%)	0.3093
Fasting (hours)	14.4±7.1	12.7±4.0	0.3625**
26-G Quincke needle	5 (62.5%)	26 (51.0%)	0.5441
No. of attempts to obtain CSF			
1/2/3 or more	7/1/0	36/10/4	0.5717
Early mobilization†			
Sitting	7 (87.5%)	30 (61.2%)††	0.1488
Standing/walking	2 (25%)	4 (8.2%)††	0.0751
Total	7 (87.5)	30 (61.2%)	0.1488

Values are number (proportion) or mean ± SD; PDPH = post-dural puncture headache; BMI = body mass index
†defined as sitting within 4 hours and/or walking within 12 hours of the procedure; ††no data were provided for 2 patients
*Chi-square test except as indicated; **t-test

TABLE 5

Patient and spinal procedure data with regard to the development of PDPH in **parturiens.**

	PDPH (n=8)	No PDPH (n=48)	P value
Age (years)	33.6±3.2	33.8±5.0	0.9367*
BMI (kg/m^2)	28.74±4.17	28.85±4.23	0.9478*
History of headache	4 (50%)	18 (37.5%)	0.2514**
Fasting (hours)	8.4±2.9	9.4±3.6	0.4316*
26-G Quincke needle	4 (50%)	28 (58.3%)	0.3296**
No. of attempts to obtain CSF			
(1/2/3 or more)	8/0/0	31/13/4	0.1276**
Early mobilization†	0	0	n.a.

Values are number (proportion) or mean ± SD; PDPH = post-dural puncture headache; BMI = body mass index
†defined as sitting within 4 hours and/or walking within 12 hours of the procedure
*t- test; **Chi-square test; n.a. = not aplicable

tive fasting time, use of 26-G Quincke needles or number of attempts to obtain CSF in either orthopaedic patients or parturients (Table 4, 5). In orthopaedic patients there was no association with female gender or early patient mobilisation. None of the parturients fullfilled the criteria for early mobilisation. In both groups patients expressed high satisfaction rate with spinal anaesthesia, i.e. 96.6% of orthopaedic patients and 94.6% of parturients would accept spinal anaesthesia for similar surgical procedure in the future.

DISCUSSION

In this study we compared the frequency and clinical significance of PDPH in two groups of patients considered to be at high risk for the development of PDPH, using standard anaesthesia technique and 26-G and 27-G Quincke spinal needles. Although pencil point needles are clearly associated with less PDPH compared to cutting needles of the same size, *(2, 4, 6, 7, 9, 12),* cutting needles are still widely used due to economic reasons and a better ease of use (13). It should be mentioned that the literature does not support the higher incidence of failed spinal anaesthesia with pencil point needles compared to cutting needles *(2, 4, 10, 14)*.

The rate of PDPH in our study was high in both parturients and orthopaedic patients (14.3% and 13.6%, respectively). Parturients have long been recognized at high risk for the development of PDPH following spinal anaesthesia or accidental dural puncture during epidural procedure. Young age and female gender are often quoted as risk factors. Because both procedures are commonly performed in parturients, a number of studies have investigated the frequency of PDPH with smaller gauge spinal needles of different size and design. In a more recent metaanalysis Choi et al. *(6)* found 6.3%, 5.6% and 2.9% rate of PDPH with 25-G, 26-G and 27-G Quincke needles, respectively. The rate of PDPH was significantly lower with atraumatic needles of the same size (Whitacre 25-G, 2.2% and 27-G, 1.7%). Similar frequency of PDPH with 25-G and 27-G Quincke (8.3% and 3.8%) and 27-G Whitacre needles (2.0%) has been reported in a recent study including 480 women scheduled for elective Caesarean section under spinal anaesthesia *(15)*.

Orthopaedic patients had arthroscopic knee surgery performed as an inpatient procedure with short hospital stay, usually two days for anterior cruciate ligament repair and one day for simple arthroscopic procedures. Patient and surgery characteristics regarding the risk of PDPH correlated more with ambulatory surgery patients then patients undergoing inpatient orthopaedic surgery in whom Lynch *et al. (14)* reported very low rate of PDPH with 27-G Quincke and Whitacre needles. However, in nonobstetric ambulatory surgery patients the rates of PDPH varied significantly between the studies even for 27-G needles. This could be, at least in part, explained by different age of patients, with some studies including patients of all ages and the other including only higher risk, young patients. Young age has not been uniformly defined with 40 and 45 years used as the inclusion limit in different studies. Kang *et al. (8)* reported 9.6% and 1.5% incidence of PDPH following the use of 26-G and 27-G Quincke needles in 730 ambulatory surgery patients with higher rates in patients who were 40 years of age or younger (11.9% with 26-G needles and 1.8% with 27-G needles). Santanen *et al. (4)* compared the incidence of PDPH and non-PDPH in 529 outpatiens undergoing spinal anaesthesia with 27-G Quincke or 27-G Whitacre needles. The frequency of PDPH was 2.7% in the Quincke group and 0.4% in the Whitacre group. Of note is that 8 patients who developed PDPH were significantly younger than the whole study population. However, much higher rates of PDPH have been reported with the use of 27-G Quincke needles (15.5%) and 27-G Whitacre needles (9.3%), as well *(10, 16)*. Other possible causes for different PDPH rates in these patients include inaccuracy in defining PDPH, variable duration of follow-up (from 2 days to 7–14 days) and different methods of follow up (daily hospital visits, telephone interview, written questionnaire).

High rates of PDPH in young parturients and orthopaedic patients in our study are possibly related to the relatively small number of patients in each group. Studies comparing the incidence of PDPH with different spinal needles where prestudy statistical power analysis was performed had estimated sample size of 100 patients or more per group. A small number of patients also explains why the frequency of use of 26-G needles was similar in patients with and without PDPH, although in the literature 26-G Quincke needles are associated with more PDPH than 27-G Quincke needles *(2, 6, 8)*. Another confounding factor is a variable and in some studies high incidence of nonspecific postoperative headache, which has been reported after spinal and general anaesthesia. Santanen *et al. (4)* reported 18.5% incidence of non-PDPH after spinal anaesthesia in 529 ambulatory surgery patients, which is higher than in the other studies *(11, 16, 17)*. The incidence of non-PDPH in our study was low, 3.4% in orthopaedic patients and 7.1% in parturients. Although the diagnosis of PDPH in the literature and in our study was dependent upon its association with body position, we cannot exclude the posibbility that some mild, short lasting PDPHs were actually non-PDPHs.

The incidence of PDPH was similar in parturients and orthopaedic patients, as was the severity and duration of the headache. The two groups differed in demographic characteristics i.e. age and gender which are considered important factors for the development of PDPH. The study included only patients younger than 40 years of age, but because of different surgical procedures and a general trend of women to give birth at an older age, orthopaedic patients were significantly younger than parturients. This could put them at higher risk for the development of PDPH. On the other hand, orthopaedic patients were predominantly male (81.4%) which could possibly decrease the risk of PDPH. In a systematic review which included more than 4000 patients, Wu *et al.*

(5) found that the odds of developing a PDPH were significantly lower (0.55) for male than nonpregnant female subjects. However, more recent studies including large number of ambulatory surgery patients found no association of PDPH with gender using 27-G Quincke and Whitacre needles *(4, 13)*. This correlates with our results on PDPH in young orthopaedic patients, which showed no relation to female gender.

Because of different characteristics of parturients and orthopaedic patients, we compared PDPH patients with no PDPH patients separately within each group. In both groups of young patients we found no further association with the age. PDPH showed no relation to prior history of headache, duration of fasting i.e perioperative fluid intake or number of attempts at dural puncture, which is consistent with previous reports *(4, 9, 13, 17, 18)*. Orthopaedic patients who developed PDPH were mobilized early in higher percentage than non PDPH patients, but the difference was not statistically significant. Because of orthostatic feature of PDPH, bed rest and supine position following dural puncture were recommended in the past to prevent PDPH. There is no clinical evidence to support this, with no difference in the incidence of PDPH with early ambulation compared to 24 hours strict bed rest *(1, 3, 17–19)*.

We would like to emphasize high success rate and high quality of spinal block with 26-G and 27-G Quincke needles in both groups of patients. Postoperative back pain is a common complaint following spinal anaesthesia that is not related to the size and design of the spinal needle *(2)*. The frequency of backpain varies between different studies from less than 10% to more than 20% *(8, 10, 11, 13, 16)*. In our study postoperative backpain was more common in parturients than orthopaedic patients, though the difference was not statistically significant. This is not surprising considering frequent complaint of low back pain in parturients. Postoperative nausea and vomiting was uncommon with no cases in parturients and 8.5% frequency in orthopaedic patients, possibly related to postoperative analgesia regimen including continuous infusion of tramadol and metamizol. Of note is high satisfaction rate of both orthopaedic patients and parturients with spinal anesthesia, which has been documented as well in literature, even in studies with high incidence of PDPH *(8, 10)*.

CONCLUSION

The rate of PDPH following spinal anesthesia with 26-G and 27-G Quincke needles was similar in young orthopaedic patients and parturients, but higher than in the literature. High success rate and high quality of spinal block on one hand and low rate of severe headache, no need for epidural blood patch and high patient satisfaction on the other hand, make 26-G and 27-G Quincke needles an acceptable technique where pencil point needles are not available. Presented data reflect everyday clinical practice, however the study should include more patients to be of sufficient statistical power.

REFERENCES

1. TURNBULL D K, SHEPHERD D B 2003 Post-dural puncture headache: pathogenesis, prevention and treatment. *Br J Anaesth 91:* 718–729
2. HALPERN S, PRESTON R 1994 Postdural puncture headache and spinal needle design. Metaanalyses. *Anesthesiology 81:* 1376–1383
3. GAISER R 2006 Postdural puncture headache. *Curr Opin Anaesthesiol 19:* 249–253
4. SANTANEN U, RAUTOMA P, LUURILA H, ERKOLA O, PERE P 2004 Comparison of 27-gauge (0.41-mm) Whitacre and Quincke spinal needles with respect to post-dural puncture headache and non-dural puncture headache. *Acta Anaesthesiolol Scand 48:* 474–479
5. WU C L, ROWLINGSTON A J, COHEN S R, MICHAELS R K, COURPAS G E, JOE E M, LIU SS 2006 Gender and post-dural puncture headache. *Anesthesiology 105:* 613–618
6. CHOI P T, GALINSKI S E, TAKEUCHI L, LUCAS S, TAMAYO C, JADAD A R 2003 PDPH is a common complication of neuraxial blockade in parturiens: a meta-analysis of obstetrical studies. *Can J Anaesth 50:* 460–469
7. LAMBERT D H, HURLEY R J, HERTWIG L, DATTA S 1997 Role of needle gauge and tip configuration in the production of lumbar puncture headache. *Reg Anesth 22:* 66–72
8. KANG S B, GOODNOUGH D E, LEE Y K, OLSON R A, BORSHOFF J A, FURLANO M M, KRUEGER L S 1992 Comparison of 26- and 27-G needles for spinal anesthesia for ambulatory surgery patients. *Anesthesiology 76:* 734–738
9. CORBEY M P, BACH A B, LECH K, FRORUP A M 1997 Grading of severity of postdural puncture headache after 27-gauge Quincke and Whitacre needles. *Acta Anaesthesiol Scand 41:* 779–784
10. DESPOND O, MEURET P, HEMMINGS G 1998 Postdural puncture headache after spinal anaesthesia in young orthopaedic outpatients using 27-g needles. *Can J Anaesth 45:* 1106–1109
11. PAN P H, FRAGNETO R, MOORE C, ROSS V 2004 Incidence of postdural puncture headache and backache, and success rate of dural puncture: comparison of two spinal needle designs. *South Med J 97:* 359–363
12. FLAATTEN H, FELTHAUS J, KUWELKER M, WISBORG T 2000 Postural post-dural puncture headache. A prospective randomised study and a meta-analysis comparing two different 0.40 mm O.D. (27g) spinal needles. *Acta Anaesthesiol Scand 44:* 643–647
13. SCHMITTNER M D, URBAN N, JANKE A, WEISS C, BUSSEN D G, BURMEISTER M A, BECK G C 2011 Influence of the pre-operative time in upright sitting position and the needle type on the incidence of post-dural puncture headache (PDPH) in patients receiving a spinal saddle block for anorectal surgery. *Int J Colorectal Dis 26:* 97–102
14. LYNCH J, KASPER S M, STRICK K, TOPALIDIS K, SCHAAF H, ZECH D, KRINGS-ERNST I 1994 The use of Quincke and Whitacre 27-gauge needles in orthopedic patients: incidence of failed spinal anesthesia and postdural puncture headache. *Anesth Analg* 79: 124–128
15. SHAIKH J M, MEMON A, MEMON M A, KHAN M 2008 Postdural puncture headache after spinal anaesthesia for caesarean section: a comparison of 25 g Quincke, 27 g Quincke and 27 g Whitacre spinal needles. *J Ayub Med Coll Abbottabad 20:* 10–13
16. FLAATTEN H, FELTHAUS J, LARSEN R, BERNHARDSEN S, KLAUSEN H 1998 Postural post-dural puncture headache after spinal and epidural anaesthesia. A randomised, double-blind study. *Acta Anaesthesiol Scand 42:* 759–764
17. HAFER J, RUPP D, WOLLBRUCK M, ENGEL J, HEMPELMANN G 1997 The effect of needle type and immobilization on postspinal headache. *Anaesthesist 46:* 860–866
18. EVANS R W, ARMON C, FROHMAN E M, GOODIN D S 2000 Assessment: Prevention of post-lumbar puncture headaches: Report of the therapeutics and technology assessment subcommittee of the American Academy of Neurology. *Neurology 55:* 909–914
19. COOK P T, DAVIES M J, BEAVIS R E 1989 Bed rest and post-lumbar puncture headache. The effectiveness of 24 hours' recumbency in reducing the incidence of postlumbar puncture headache. *Anaesthesia 44:* 389–391