Greater Occipital Nerve Block or Suboccipital Intramuscular Injections are effective for management of Postdural Puncture Headache: A placebo-controlled study

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Abstract

Background: Postdural puncture headache (PDPH) is not uncommon complication of neuroaxial anesthesia and it affects the mother and the newborn. PDPH may be resistant to conservative management and requires intervention.

Objectives: To evaluate the outcomes of bilateral greater occipital nerve block (GONB) and bilateral suboccipital intramuscular injection in a placebo-controlled study for management of PDPH.

Patients and methods: 50 patients received bilateral saline injection, 32 patients received suboccipital intramuscular injection and 33 patients received GONB using a mixture of 40 mg lidocaine and 8 mg dexamethasone injection**.** Pain severity was assessed using the Numeric Rating Scale at baseline and weekly for 4-wks and monthly for 6-m after block, Pain-induced disability was assessed using the Oswestry Pain Disability Questionnaire (OPDQ) score and analgesic requirements were graded at baseline, 1-, 3- and 6-m after block. The success rate was defined at the end of 6-m follow-up as the frequency of patients who stopped consumption of analgesia and/or had minimal-to-mild disability with OPDQ score of <20.

Results: The success rates were 46.2% depending on number of women had stopped analgesia and 52.3% depending on the OPDQ score and was significantly higher among patients received GONB. Patients' distribution according to satisfaction grade was significantly higher in study groups than control groups with non-significant differences between the study groups.

Conclusion: The applied procedures are effective for reducing pain severity, consumption of analgesics and improving disability. GONB provided significantly higher success rate, but the choice of the procedure may be according to preference of the service provider.

Keywords: Postdural puncture headache; Greater occipital nerve block; Suboccipital intramuscular injection, pain severity; Pain-induced disability.

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Introduction

Postdural puncture headache (PDPH) is the commonest complication of neuroaxial block especially for obstetric anesthesia **(Poteau et al., 2022)**. Classically, patients of PDPH present by headache that developed within 5-days after dural puncture and is aggravated by standing or setting and relieved with lying down **(Headache Society, 2018)** to compensate for the resultant intracranial hypotension secondary to cerebrospinal fluid leakage through the dural tear as evidenced by imaging studies **(Seong & Kwon, 2020)**.

The incidence of PDPH varies widely in the literature and ranges between 1-10% but affects about 0.7% of obstetric patients received neuroaxial anesthesia **(Meshram et al., 2020)**. The presence of non-modifiable patient-related risk factors and the modifiable procedure-related risk factors may explain the wide range of PDPH incidence **(Weji et al., 2020)**.

Multiple pathophysiological bases for development of PDPH were suggested as the decreased CSF pressure and volume due to leakage through the dural tear of CSF, which may affect pain-sensitive structures, trigger compensatory vasodilatation to increase blood flow or induce decreased levels of substance P causing headache **(Abate et al., 2021)**.

Typically, PDPH is spontaneously resolving condition through 2-weeks of onset; however, this may affect the neonatal care by the affected mother **(Roytman et al., 2021)**. This necessitated some interventions to improve mothers' complaints as limiting patients' mobility, bed rest, prone position, hydration, caffeine and analgesics, but its effectiveness is uncertain **(April et al., 2018)**, methylxanthine drug was suggested to decrease the number of patients with PDPH **(Ona et al., 2015)** and the invasive technique of autologous epidural blood patch (EBP) may be required for persistent cases **(Urits et al., 2020)**. This study tried to evaluate the short and long-term effect of bilateral greater occipital nerve block (GONB) in comparison to suboccipital intramuscular injection for management of PDPH.

Patients and methods

This is a multicenter placebo-controlled comparative study. All women presenting by headache after receiving spinal anesthesia for cesarean section since June 2019 till April 2022 were eligible for evaluation.

Inclusion criteria: Inclusion criteria are the fulfillment of the classical features of PDPH according to the International Classification of Headache Disorders, which include headache occurred within 5 days of lumbar puncture, aggravated with standing or sitting position, relieved with lying down, and did not remit spontaneously within 2 weeks **(International Headache Society, 2018)**.

Exclusion criteria: The presence of neurological or psychological disorders, organic headache, migraine, headache-associated medical conditions, referred head pain, persistent hypotension, coagulopathy, and refusal of study participation or being missed during follow-up are the exclusion criteria.

Setting: Department of Anesthesia, ICU and Pain, Faculty of Medicine, Benha University in conjunction with multiple private obstetric centers

Ethical Considerations: The study protocol was discussed with patients after obtaining the preliminary approval at June 2019 and patients who accepted to receive any type of intervention and to attend the follow-up visits were enrolled in the study.

After the end of 6-m follow-up for the last case enrolled in the study, the study outcomes were approved by the Local Ethical Committee, Benha University by RC: 15.11.22

Blindness: The pre-procedural evaluation and preparation of medications were the responsibility of an assistant not included as an author. The authors were blinded about the pre-procedural pain evaluation data till the 1st follow-up visit, were responsible for application of the procedure, and collection and analysis of post-procedural data. Patients were blinded about the medication and type of procedure to be used.

Clinical evaluation: History taking included inquiry about previous receiving neuroaxial anesthesia, previous PDPH, presence of any form of headache before receiving the anesthesia, associated medical conditions and parity. Age and BMI data were collected then general examination was performed.

Evaluation Tools

1. Pain history was assessed for the following items: time of pain onset after anesthesia, causes of pain aggravation or relieve and the effect of previous lines of management if any, the use of analgesia, its type and form, number of doses, and effect.
2. Pain severity was assessed using an 11-point Numeric Rating Scale (NRS) with 0 indicates no pain and 10 indicates worst pain imaginable **(Williamson & Hoggart, 2005)**.
3. Pain-induced disability was assessed using the Oswestry Pain Disability Questionnaire (OPDQ) that covers 10 items, each item was scored from 0 to 5 according to increased disability and a total score was calculated to determine the disability grade **(Fairbank & Pynsent 2000)**.
4. Pain medication requirements were graded using a 0-4 point scale with 0 indicates no medication and 4 indicate regular use of opioid medications.

Randomization: Study grouping depended on a sequence producing program to deliver a proposed sequence of 1:1 irrespective of number of participants. Another sequence generation was applied for the proposed number of each group to divide each group into two subgroups; control and study (A&B) to provide a control group for each of the applied procedures. The obtained sequences were transformed into group labels IA, IB, IIA and IIB written on small cards enclosed in envelops and patients were asked to choose one envelope and propose it to the assistant who was responsible for preparation of medication and provide the author with the syringes to be used for this patient.

Grouping: Patients were randomly divided into four equal subgroups at time of enrolment. Groups IA and IIA received placebo, group IB received bilateral suboccipital intramuscular injection and group-IIB received bilateral GONB. Patient who refused a procedure at time of undertaking the procedure was discussed and on persistent refusal, patient was excluded from the study.

Medications: Patients of groups IB and IIB received bilateral injection of a mixture of 2% lidocaine (2ml; 40 mg) and 8 mg dexamethasone (2-ml) for a total of 4-ml to be injected 2-ml in each side, while patients of group IA and IIA received 4-ml saline as placebo.

Procedure

1. Bilateral suboccipital intramuscular injection was performed blindly for patients of group-I as previously described by **Abdelraouf et al., (2019)**, with the patient was sitting

on chair and neck was maximally flexed.

2. Bilateral GONB
   - Localization of greater occipital nerve (GON) as described by **Mosser et al., (2004)** with the patient in setting position and neck was flexed, the occipital artery was localized at the junction of medial third and lateral two-thirds of a line draw between the external occipital protuberance (EOP) and the mastoid process and the GON was localized often just medial to the artery in a region where no muscle is present.
   - Injection procedure was performed as was described by **Young et al. (2008)**; after localization of GON, pressure was applied to this region and tenderness assured the correct location and 2-ml of the mixture was injected at this location and the procedure was repeated in the other side to achieve bilateral block.

Post-procedural Evaluation

1. Immediate procedure-induced complications; failure of the trial, hematoma formation and injection site infection.
2. Evaluation using NRS pain scores at 1-wk, 2-wk, 1-m after the procedure and then monthly till 6-m follow-up.
3. The OPDQ scores were re-evaluated at 1, 3 and 6-m after procedure and patients were stratified according to the grade of disability at the 6th month of follow-up as minimal (ODI= 0–9), mild (score=10-19), moderate (ODI=20–39), severe (ODI= 40–59), crippled (score= 60-79) and score> 80 indicates patient is either bedridden or exaggerating her symptoms **(Manchikanti et al., 2010)**.
4. Patients' distribution according the type of medication was re-evaluated at 1-m, 3-m and 6-m after procedure.

Study outcomes

1. The success rate of the applied procedures was defined at the end of 6-m follow-up as the frequency of patients who stopped consumption of analgesia and/or had minimal-to-mild pain-induced disability with OPDQ score of <20.
2. The efficacy of the applied procedures in relation to placebo and to each other
3. Patients' satisfaction by the outcome as graded on 4-point grading: excellent, good, fair and poor.

Statistical analysis

Data are presented as mean, standard deviation, numbers, and percentages. Intra-group differences were evaluated using One-way ANOVA test. Percentages data were evaluated using Chi-square. Statistical analysis was conducted using IBM® SPSS® Statistics (Version 22, 2015; Armonk, USA) for Windows. The significance of the difference was determined at P value of <0.05 as significant.

Results

During the study duration 172 women had presented by PDPH; 8 patients had pre-spinal headache, 4 had previous PDPH, 3 patients had neurological disorders and two patients were psychologically instable and another 11 women refused the inclusion in the study, these 28 women were excluded from the study and 144 patients were divided randomly into four subgroups (n=36). Unfortunately, during follow-up 29 patients were missed and statistical analysis was performed for data of 116 patients

(**Fig. 1**). Enrollment data of the included patients showed non-significant difference as shown in (**Table 1**).

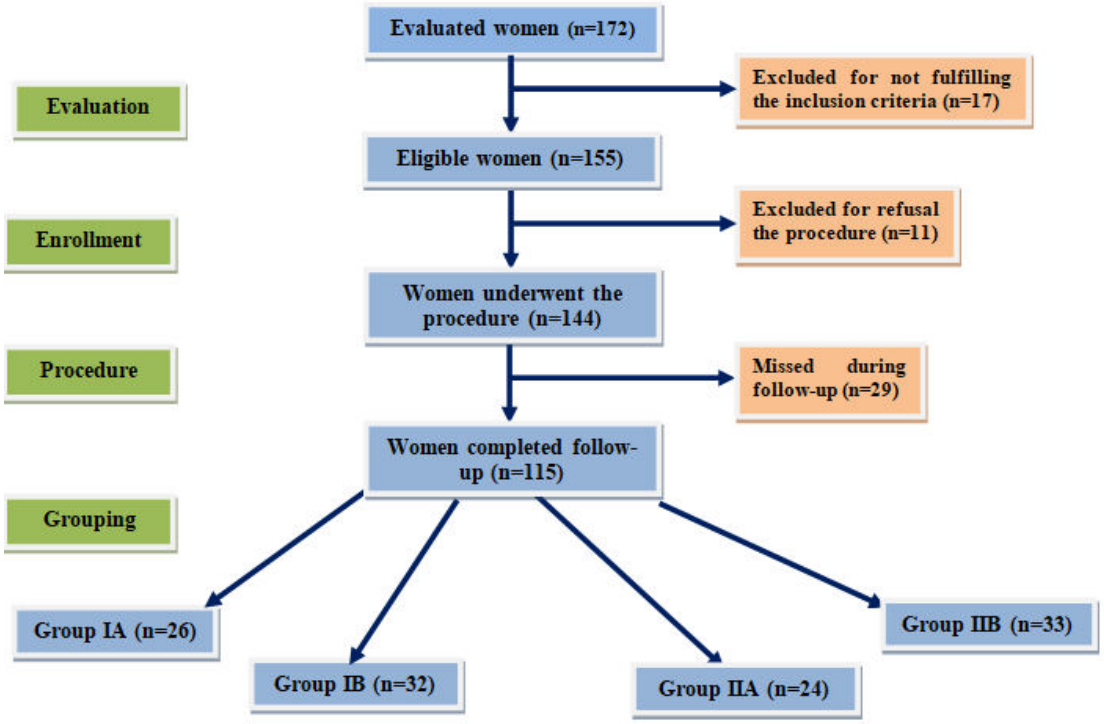

Fig.1. Study flowchart

Table 1. Enrolment data of patients of studied groups

Variables	Group-I		Group-II		P-value
	IA (n=26)	IB (n=32)	IIA (n=24)	IIB (n=33)	
Age (years)	29±5.3	28.5±2.8	30±3.5	29.1±3.3	0.532
Body mass index (kg/m^2)	28.7±1.8	28.7±2	28.2±1.8	28.9±2.1	0.648
Parity	2.2±0.9	2±0.8	2.3±0.9	2±0.9	0.567
Time of onset of pain (days)	6±1.2	5.5±1.1	6±1.7	6.2±1.1	0.149

The applied procedures significantly reduced pain scores throughout 6-m follow-up in comparison to their respective controls with non-significant differences between both control groups (IA & IIA) and between both study groups (IB & IIB) as shown in (**Table .2**).

Table 2. Pain scores recorded during 6-m follow-up for patients of the studied groups

Time	Group-I			Group-II				
	IA	IB	P1	IIA	P1	IIB	P2	P3
Baseline	6.6±1.4	6.7±1.1	0.646	6.5±1.1	0.913	6.9±1.4	0.335	0.379
1-wk	5.5±1.9	4±1	0.002	6±0.9	0.178	3.6±2.3	<0.001	0.425

2-wk	5.4±1.5	3.8±1.1	<0.001	5.8±1.1	0.142	3.7±2.4	<0.001	0.670
1-m	5.6±1.4	3.8±1.4	<0.001	6±1.1	0.266	3.8±2.4	<0.001	0.947
2-m	5.7±1.3	3.9±1.6	0.001	6±1.1	0.314	3.9±2.5	<0.001	0.905
3-m	5.5±1.5	4±1.6	0.003	6.1±1.3	0.126	3.9±2.4	<0.001	0.761
4-m	5.7±1.5	4.2±1.7	0.007	6±1.4	0.266	3.8±2.4	0.0001	0.479
5-m	6±1.3	4.1±1.8	0.0002	6±1.2	0.821	3.8±2.5	0.0001	0.679
6-m	6.1±1.4	4±1.9	0.0002	6±1.4	0.917	3.9±2.4	0.0002	0.907

P1: indicates significance of difference versus group-IA; P2: indicates significance of difference versus group-IIA; P3: indicates significance of difference versus group-IB; P<0.05 indicates significant difference

Patients of groups IB and IIB showed significantly (P<0.001) lower pain scores in comparison to their baseline scores. Interestingly, patients of groups IA and IIA also showed significantly (P=0.015 & 0.002, respectively) lower pain scores in comparison to their baseline score (**Fig. 2**).

Fig.2. Mean pain score determined at baseline and 6-m post-procedure

All patients showed improved pain-induced disability in parallel to decreasing pain scores; patients of groups IB and IIB showed progressive decreases of their OPDQ scores with significant differences in comparison to corresponding scores of groups IA (P=0.029 & 0.008) and IIA (P=0.0001 & <0.001) at 3-m and 6-m, respectively. Further, the recorded OPDQ scores of patients of group IIB were significantly lower (P=0.047 & 0.003) than scores of patients of group-IB at 3-m and 6-m, respectively. The improvement was earlier, at 1-m, in patients of group IIB with significant (P=0.0037) difference versus scores of patients of group IIA, while in case of group I the difference was non-significant (P=0.088) between its subgroups (**Table 3 & Fig. 3**).

Table 3. OPDQ scores recorded during 6-m follow-up for patients of the studied groups

Time	Group-I			Group-II				
	IA	IB	P1	IIA	P1	IIB	P2	P3
Baseline	27.8±5.9	27±7.3	0.769	27.5±5.4	0.711	25.8±5.7	0.349	0.566
1-m	27.1±6	23.9±7.6	0.088	26.8±6.6	0.874	21.8±5.9	0.0037	0.203
3-m	26.8±6.2	22.3±8.6	0.029	26.8±7.3	0.983	18.4±7.1	0.0001	0.047
6-m	27.1±7.1	20.7±10	0.008	26.5±7.6	0.750	13.5±8.5	<0.001	0.003

P1: indicates significance of difference versus group-IA; P2: indicates significance of difference versus group-IIA; P3: indicates significance of difference versus group-IB; P<0.05 indicates significant difference

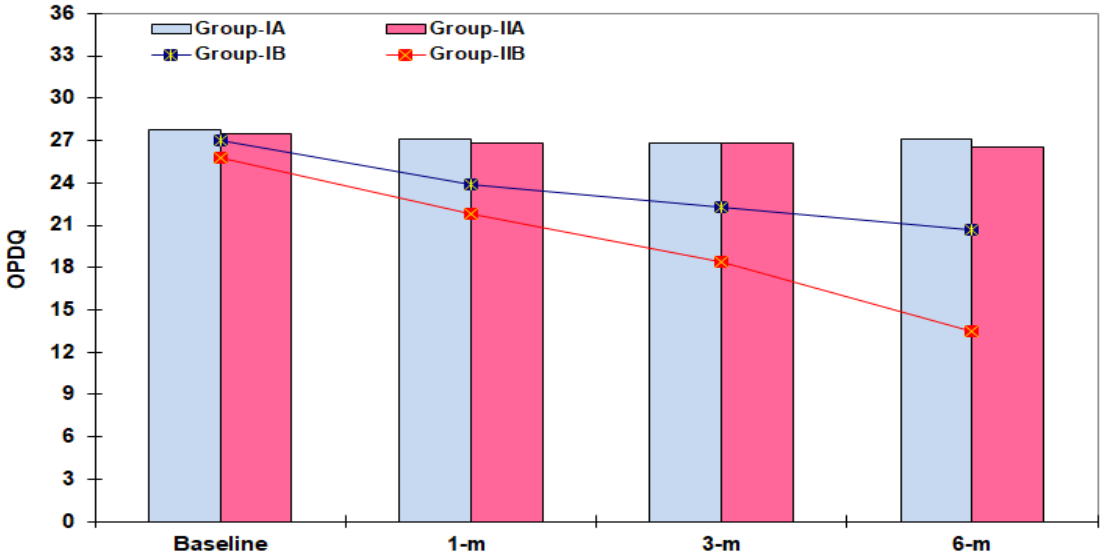

Fig.3. The recorded OPDQ of patients of the studied groups till end of follow-up

According to disability grades, at the end of follow-up, 26 patients (78.8%) in group-IIB and 18 patients (56.3%) in group-IB had minimal-to-mild disability OPDQ score <20) with non-significant difference (P=0.082) in favor of group-IIB. In comparison to the disability grades at time of enrolment, the frequency of patients had minimal-to-mild disability at 6-m follow-up was significantly higher in groups IB and IIB (P=0.0018 & <0.001, respectively) as shown in (**Fig.4**).

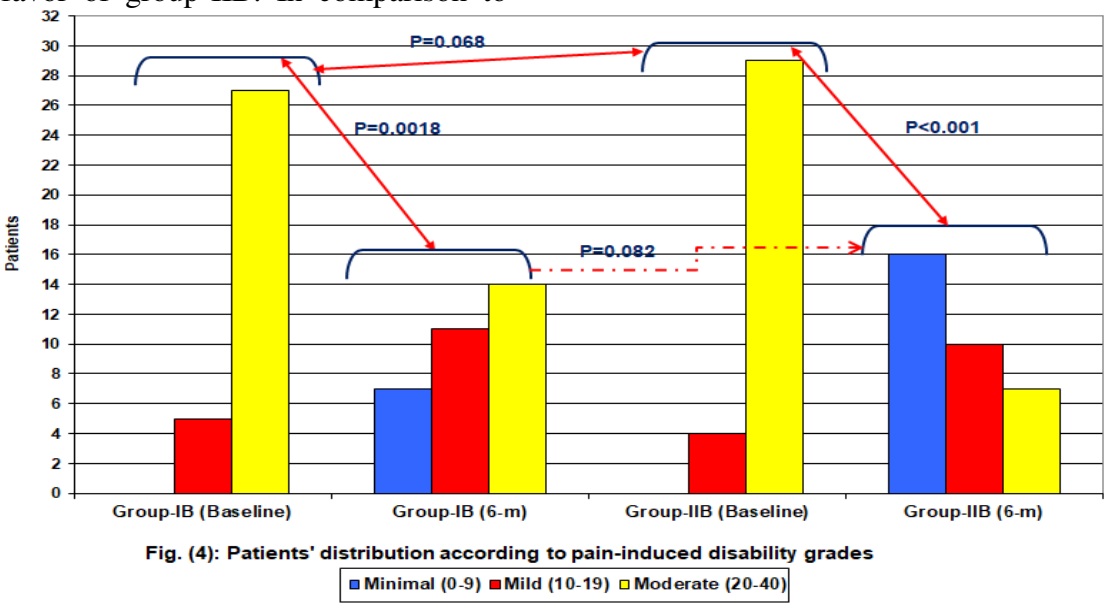

Fig. (4): Patients' distribution according to pain-induced disability grades

There were non-significant differences between the frequency of patients of groups I-A and II-A according to the types of medications used till the end of 6-m follow-up. Regarding patients of group-IB, patients' distribution according to the types of medications used showed non-significant difference at baseline and 1-m, while the difference was significant thereafter in comparison to group-IA; while in case of group-IIB the difference was significant since 1-m post-procedure. The differences in the frequencies between patients of groups IB and IIB was non-significant at baseline and 1-m post-procedural, while at 3-m and 6-m post-procedural the difference in frequency was significant (P=0.045 & 0.031, respectively) in favor of group-IIB (**Table 4**).

Table 4. Patients distribution according to type of analgesia used during 6-m follow-up

Variables		Group-IA				Group-IB			
Medications Time		Baseline	1-m	3-m	6-m	Baseline	1-m	3-m	6-m
No		0	0	0	1 (3.8%)	0	0	4 (12.5%)	9 (28.1%)
Occasional/non-opioid		0	3 (11.5%)	4 (15.4%)	5 (19.2%)	0	13 (40.6%)	16 (50%)	14 (43.8%)
Regular/non-opioid		21 (80.8%)	19 (73.1%)	18 (69.2%)	17 (65.4%)	23 (71.9%)	17 (53.1%)	11 (34.4%)	8 (25%)
Occasional/opioid		5 (19.2%)	4 (15.4%)	4 (15.4%)	3 (11.6%)	9 (28.1%)	2 (6.3%)	1 (3.1%)	1 (3.1%)
Significance of difference vs. Group IA						0.413	0.086	0.0026	0.0024
Variables		**Group-IIA**				**Group-IIB**			
Medications Time		**Baseline**	**1-m**	**3-m**	**6-m**	**Baseline**	**1-m**	**3-m**	**6-m**
No		0	0	0	1 (4.2%)	0	0	13 (39.4%)	21 (63.7%)
Occasional/non-opioid		0	3 (12.5%)	4 (16.7%)	5 (20.8%)	2 (6.1%)	18 (54.5%)	15 (45.5%)	7 (21.2%)
Regular/non-opioid		19 (79.2%)	17 (70.8%)	16 (66.6%)	15 (62.5%)	22 (66.7%)	15 (45.5%)	5 (15.1%)	5 (15.1%)
Occasional/opioid		5 (20.8%)	4 (16.7%)	4 (16.7%)	3 (12.5%)	9 (27.2%)	0	0	0
Significance of difference vs.	**Group I**	0.884	0.984	0.981	0.997	0.367	0.233	0.045	0.031
	Group IIA					0.405	0.001	<0.001	<0.001

The frequency of patients who had stopped consumption of analgesia was significantly higher in group-IIB versus group-IB (39.4% vs. 12.5%; P=0.011) at 3-m and (63.7% vs. 28.1%; p=0.004) at 6-m post-procedural (**Fig. 5**).

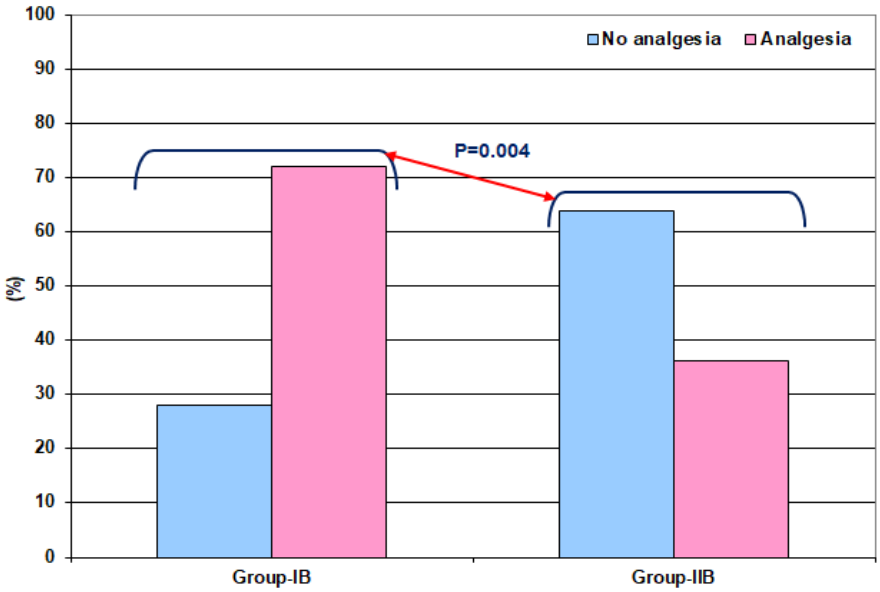

Fig. (5): The frequency of patients of study groups according to consumption of analgesia at 6-m post-procedural

At the end of follow-up, the success rate depending on number of women had stopped analgesia was 46.2% and depending on the OPDQ score was 52.3% of patients received lidocaine/dexamethasone mixture. Further, 33 patients (50.8%) of groups IB and IIB found the outcomes are excellent, 17 patients (26.2%) found the outcome is good, 9 patients (13.8%) commented by fair satisfaction and only 6 patients (9.2%) found the outcomes are poor and unsatisfactory. Regarding patients of groups IA and IB, 19 patients (38%) were unsatisfied, 17 patients (34%) and 11 patients (22%) found the outcomes were fair and good respectively and only 3 patients (6%) in group IIB found the outcomes are satisfactory. Patients' distribution according to satisfaction grade was significantly higher in groups IB (P=0.0001) and IIB (P=0.0015) in comparison to distribution among groups IA and IIA, respectively with non-significant differences between groups IB and IIB in comparison to groups IIA and IIB (P=0.315 & 0.111, respectively), as shown in (**Fig. 6**).

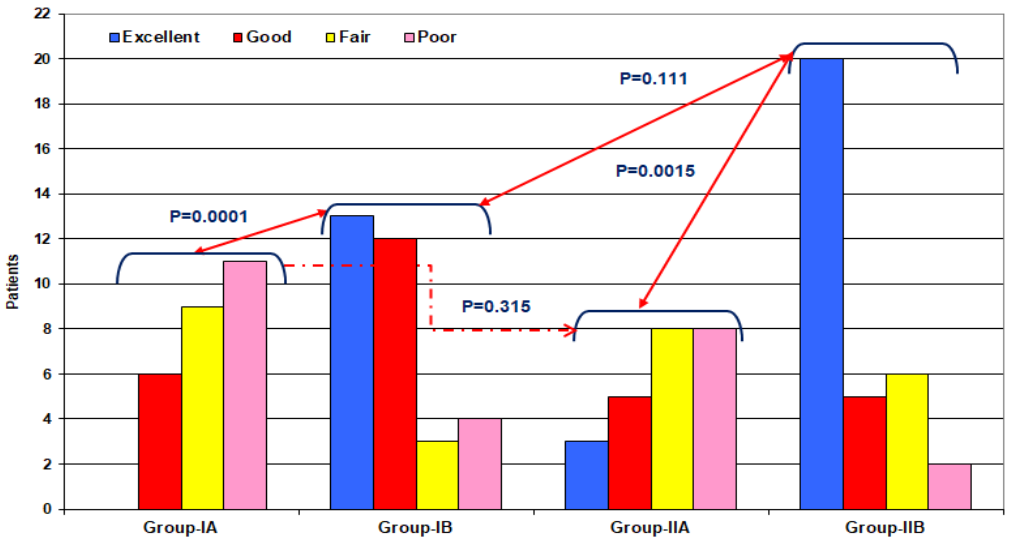

Fig. (6): Patients' distribution according to satisfaction by the outcome of the procedure

Discussion

The current study collected only females within age range of 22-38 who developed PDPH after spinal anesthesia for cesarean section because, as previously documented by **Meshram et al., (2020)** it is the most frequently affected population and to prevent the bias of the results due to inclusion of males and females, wide age range and varied indications for spinal anesthesia. These inclusion criteria go in hand with the recently documented by **Al-Hashel et al., (2022)** as risk factors for getting PDPH. Further, all included women fulfilled the inclusion criteria for PDPH as previously documented by the Headache Classification Committee of the International Headache Society **(International Headache Society, 2018)**.

The reported success rate at the end of 6-m follow-up was 46.2% and 52.3% depending on number of women who had stopped analgesia or had OPDQ score <20, and these success rates were associated with patients' grading of total outcome as excellent by 50.8% and as good by 26.2% of patients received lidocaine/dexamethasone mixture. The reported high success rates of these procedures in addition to its attractive features of being simple, minimally invasive, could be applied as office procedure, spare hospital admission, anesthesia or application of epidural blood patch (EBP) and preserve the hospital and patients' resources, so any of these procedure could be advocated as the initial management of PDPH patients .

Differentially, the success rate for suboccipital intramuscular injection was 28.1%, 56.3% and 78.1% as regards the frequency of women who stopped analgesia, had OPDQ<20 and found the outcome excellent-to-good, respectively. These outcomes are in hand with **Abdelraouf et al., (2019)** who found the suboccipital intramuscular injection procedure allowed getting lower headache score at all the post-injection time points, resolution of nausea and longer duration to request analgesia than placebo. The reported success rate for the intramuscular lidocaine/dexamethasone mixture in the suboccipital region may be attributed to induction of relieve of exaggerated excitability of occipital nerves supplying the muscles of the back of neck, such high excitability is aggravated by the head-upright position with subsequent development of clonus contractions of neck muscles leading to vascular compressions with venous and lymphatic engorgement, thus causing hypoxia-induced pain and accumulation of nociceptive metabolites. A similar description and explanation was provided for cases diagnosed as occipital neuropathy **(Swanson et al., 2022)** and in support of this explanation **Kaga (2022)** found repeated hydro-dissection procedure for three settings allowed headache episodes to disappear and **Pietramaggiori & Scherer (2023)** reported an improvement of headache by 50% in 91% of patients and 45% of patients reported complete remission of pain after surgical decompression of occipital nerves.

Regarding GONB the success rates were 63.7%, 78.8% and 75.8% for stoppage of analgesia, OPDQ score <20 and satisfaction rates, respectively with significantly higher difference compared to rates obtained by suboccipital intramuscular injection. This could be attributed to the rational of each procedure, where the suboccipital intramuscular injection relies on fluid diffusion in the tissue spaces, so acting on the nerve fibers and terminals and this gives a chance for some of these terminals to escape

the fluid, while GONB is a type of direct injection of the nerve at its exit point and so it acts on the nerve trunk not the terminals.

Moreover, blinded nerve exit localization was feasible depending on the anatomical landmarks as documented in early literature that there is a consistent pattern in the relationship between the GON and the occipital artery after its exit from the trapezius fascia **(Saracco et al., 2010, Janis et al., 2010)**. Thereafter, **Shin et al., (2018)** suggested localization of GON at point of junction between medial third and lateral two-thirds of the line extending between the external occipital protuberance (EOP) and mastoid process and considered this point as the safe injection point. Recently, **Huanmanop et al., (2021)** documented that the mastoid-EOP is a potential reference line for locating the subcutaneous piercing point of GON, which is applied in the current study. On contrary, proper suboccipital intramuscular injection requires localization of the intramuscular nerve dense region in the suboccipital muscle to allow defining the accurate puncture position and depth of the center as documented by **Wang et al., (2022)**, so **Abdelraouf et al., (2019)** depended on ultrasound localization of injection site.

The obtained results concerning GONB supported that previously reported by **Pingree et al., (2017)** who detected significantly progressive reductions in pain scores over 4-wk without adverse events after US-guided GONB at the level of C2 and **Salem et al., (2019)** who concluded that bilateral GONB is simple, minimally invasive, safe and efficient therapeutic modality for PDPH and reduced the need for epidural blood patch down to 11.4%.

Recent Meta-analysis and systemic review of literature suggested that GONB is effective management of PDPH because of its early effect in reducing pain severity, sustained effect following a single injection, and the technique is easy, minimally invasiveness, and with negligible cost **(Chang et al., 2021; Giaccari et al., 2021; Chowdhury et al., 2021)**. Thereafter, **Azzi et al., (2022)** retrospectively suggested that US-guided GONB is a minimally risky and efficacious technique for patients developed PDPH and failed to respond to conservative treatment**.** Further, **Arab et al., (2022)** reported significant improvement of headache frequency, duration and severity after GONB with local anesthetic and triamcinolone.

In support of the efficacy of GONB, **Youssef et al., (2021)** in a comparative study concluded that both GONB and sphenopalatine ganglion block are safe, simple, and are equally effective in relieving PDPH, and less invasive than epidural blood patch. Recently, **Niraj & Critchley (2023)** found GOND produced durable benefit for patients had accidental dural puncture lasting for 6-m in 86% of patients and at final follow-up, found the mean monthly headache frequency was 5.9, 8.6 and 4.1 for patients received medical management, patients refused GONB and patients who received GONB.

Conclusion

The applied procedures for management of PDPH are effective for reducing pain severity, consumption of analgesics and improving pain-induced disability. However, GONB provided significantly higher success rate and so is advocated as the procedure of choice for PDPH management. Considering the simplicity of both procedures the pain physician could apply the most familiar technique according to high preference.

Recommendations

Being effective procedures, it could be applied earlier than waiting

for spontaneous resolution, if any so as to improve patients' quality of life.

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