



## Research Article

# Sekar's DISH10 (Deep Inspiration, Squeeze & Hold for 10 seconds) Maneuver- A Novel, Non-invasive and Cost-effective Treatment for Postdural Puncture Headache – A Comparative Cohort Study

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## Abstract

**Introduction:** Postdural puncture headache (PDPH) is one of the iatrogenic complications of the neuraxial blockade. Its incidence has steadily declined with advances in anesthesia techniques, improved knowledge of pathophysiology, and the implementation of preventable measures. However, it has the potential to cause significant morbidity in affected individuals. This article introduces a new non-invasive and cost-effective treatment for PDPH termed DISH10 (Deep Inspiration, Squeeze & Hold for 10 seconds) maneuver. It also describes the essential steps involved in the DISH10 maneuver and discusses various biomechanics associated with these steps. We hypothesize that the DISH10 maneuver hastens spontaneous recovery by increasing intrathoracic and intraabdominal pressure and provides quick relief.

**Methods:** This comparative cohort study includes 100 PDPH patients in three years, from January 2018 to March 2021. This study is divided into two groups. Group 1 included a prospective case series of 50 patients of PDPH treated with DISH10 maneuver. Group 2 included a retrospective cohort of 50 patients of PDPH treated with conventional conservative management with or without sphenopalatine ganglion block (SPGB). The demographics, type of neuraxial anesthesia, size/type of spinal needle, time to develop headache, and time to outcome were noted.

**Results:** The incidence of PDPH was higher with 25G spinal needles (Quincke) in both the groups (82% in DISH10 and 74% in group 2) than with 27G spinal needles (Whitacre). The median of time to outcome (time to make patients symptom-free) with DISH10 maneuver was significantly lower (7 hours) than the conservative group (48 hours). All 50 patients in Group 1 (case series) became symptoms-free and ready to discharge within 24 hours of commencement of the DISH10 maneuver.

**Conclusion:** The DISH10 maneuver has shown better results than conventional conservative management with or without SPGB in terms of treatment duration, time to discharge, and total hospital stays, making the DISH10 maneuver a cost-effective option.



## Abbreviations

**PDPH:** Postdural Puncture Headache; **SPGB:** Sphenopalatine Ganglion Block; **DISH10:** Deep Inspiration Squeeze and Hold for 10 Seconds; **SA:** Spinal Anesthesia; **RA:** Regional Analgesia; **CSF:** Cerebrospinal Fluid; **VAS:** Visual Analog Scale; **FG:** Functional Grading; **EBP:** Epidural Blood Patch; **VM:** Valsalva Maneuver; **CPP:** Cerebral Perfusion Pressure; **MAP:** Mean Arterial Pressure

## Introduction

August Bier first described postdural puncture headache (PDPH) in 1899 after self experiencing it following spinal anesthesia (SA) [1]. PDPH is one of the common complications of the neuraxial blockade, with the incidence varies from 0.3%–20% following SA and about 70% after an accidental dural puncture [2]. Symptoms develop within 48 hours to 5 days after the procedure. In the modern anesthesia practice, the rates of PDPH following SA have steadily declined, from an incidence exceeding 50% in Bier's time to around 10% in the 1950s [3], until currently a rate of 1% or less can be reasonably expected.

Many questions still remain unanswered despite various management strategies (conservative, non-pharmacological, pharmacological, and interventional therapies) described in the literature to treat PDPH. Few regional anesthesia (RA) techniques like erector spinae plane block at T4 [4], greater occipital nerve block [5], and sphenopalatine ganglion block (SPGB) [6] provided symptomatic relief. Such modalities are either partially effective, time-consuming, expensive, difficult to perform, and/or associated with complications. One of the authors (CS) attempted to circumvent all these issues and devised a novel, non-invasive and cost-effective maneuver called Sekar's DISH10 (Deep Inspiration, Squeeze & Hold for 10 seconds) maneuver.

We hypothesize that the DISH10 maneuver maximizes intrathoracic and intra-abdominal pressure sufficiently to engorge epidural vessels. That leads to the increased epidural pressure, which stops cerebrospinal fluid (CSF) leakage and restores its homeostasis. Thus, the DISH10 maneuver potentially hastens spontaneous recovery by providing quick relief and increasing patient satisfaction. We have successfully treated many PDPH patients (since 2018) after incorporating the DISH10 maneuver into our treatment protocol. We aim to describe the results of this comparative cohort study between Group 1 of the prospective case series (n=50) and Group 2 of the retrospectively obtained cohort group (n=50). This article mainly highlights the technical consideration of the DISH10 maneuver and elaborates the probable mechanisms by which it provides quick symptomatic relief and reduces the treatment duration.

## Methods

This comparative cohort study included 100 admitted patients who developed PDPH following neuraxial anesthesia for lower extremity orthopedic surgeries performed at a tertiary care centre (Ganga Medical Centre and Hospitals

Private Limited, Coimbatore, India) from January 2018 to March 2021. The study was divided into two groups: Group 1 included a prospective case series of 50 cases in which PDPH was treated with DISH10 maneuver, and Group 2 included a retrospective cohort of 50 cases in which PDPH was treated with conventional conservative management with or without SPGB.

## Inclusion criteria

1. Patients (ASA grade I and II) of all age groups admitted for lower extremity orthopedic surgeries under neuraxial blockade and diagnosed to have PDPH in the postoperative period
2. PDPH patient treated with DISH10 maneuver (Group 1)
3. PDPH patients treated with conventional conservative management with or without sphenopalatine ganglion block (Group 2).

## Exclusion criteria

1. ASA III/IV patients
2. Patient's refusal (Group 1)
3. Patients with PDPH treated with DISH10 maneuver after the failure of conservative trial for more than two days
4. Incomplete case related documents (Group 2)
5. Polytrauma patients
6. Patients who are defaulters.

## Group 1

After obtaining approval from the Institutional Review Board (IRB) committee at Ganga Medical Centre & Hospitals Private Limited, a total of 50 patients satisfying the inclusion criteria were included in this cohort of prospective case series. In these patients, the PDPH was diagnosed by the duty anesthetist, based on the following criteria

- I. Positional headache: Aggravated in sitting/erect position and improved in supine/lying position
- II. Location: Frontal or occipital, or both
- III. Associated symptoms: Generalized symptoms (nausea, dizziness, neck stiffness) or localized symptoms (auditory and/or visual hallucinations/phenomena)
- IV. Onset: Within 12–48 hours to rarely more than five days post neuraxial blockade.

The severity of the headaches was graded based on the visual analog scale (VAS) from 0–10 (where 0 =no pain and 10 =the worse pain imaginable) and the functional grading (FG) from 1–3 scale (where, 1= headache not interfering with regular daily activity, 2= headache requiring periodical bedrest to get relief, and 3= severe headache not allowing the patient to sit up and eat).



Combining both scores, the severity of postdural puncture headache graded as grade 0- no headaches, 1- mild (corresponds to FG 1+ and VAS 1-3), 2- moderate (corresponds to FG 2+ and VAS 4-7), and 3- severe (corresponds to FG 3+ and VAS 8-10).

We kept all patients under observation in the special ward with standard basic hemodynamic monitoring facilities to record events, provide further care, and assist them in performing the DISH10 maneuver. We advised them to increase fluid intake, take bed rest, and continue their ongoing multimodal analgesics (oral paracetamol 1g qid, aceclofenac 100 mg bd, and pregabalin 75 mg hs). We explained the steps of the DISH10 maneuver and its possible side effects like dizziness, nausea, or vomiting (Table 1). After discussing the risk-benefit ratio, we asked them to perform the DISH10 maneuver at regular intervals.

We noted the severity of the headache after the DISH10 maneuver at the 5<sup>th</sup>, 7<sup>th</sup>, 10<sup>th</sup>, 12<sup>th</sup>, 18<sup>th</sup>, and 24<sup>th</sup> hours (Figure 1). The first ten patients were kept under observation in a high dependency unit for 24 hours, 20 patients for 12 hours, and the remaining 20 patients for 8 hours only. We shifted all the patients to their rooms/wards from the monitoring facility after confirming adequate relief of the symptoms. We advised them to inform the duty anesthetist about the

symptoms' recurrence and perform the same maneuver for 2-3 hours. During hospital discharge, we advised all patients to contact the attending anesthetist (one of the authors) upon the recurrence of symptoms and perform the same maneuver as advised for another 2-3 hours at that time. Fortunately, no patients reported the relapse of headaches during telephonic as well as physical follow-ups. All patients included in this prospective case series, or their next-of-kin provided informed consent for anonymous data recording and sharing concerning this procedure.

### Group 2

We performed the retrospective analysis of the case-related documents (between the year 2018-2021) of the PDPH patients who received only conservative management (with or without SPGB). A total of 50 cases were included (as per the inclusion criteria) in this retrospective cohort group, divided into two subgroups. The first subgroup (n=33) consists of those PDPH patients who received only conservative management such as bed rest, adequate hydration, multimodal analgesics, and caffeinated drinks. The second subgroup (n=17) consists of patients who received SPGB three times a day with conservative management.

**Table 1:** Steps of DISH10 maneuver and possible hemodynamic fluctuations.

<b>Sekar's DISH10 Maneuver</b> (An innovative, non-invasive, and cost-effective treatment of PDPH)		
❖ <b>Type of Patients :</b> • Patients with a confirmed diagnosis of PDPH		
❖ <b>Patient position :</b> • Supine/lying down on the bed with the slightly raised foot end		
<b>Steps of DISH10 Maneuver</b>		
1.	Deep Inspiration (DI):	• Ask the patient to take deep inspiration and hold the breath
2.	Squeeze (S):	• After holding breath, ask the patient to squeeze his chest and abdomen together, mimicking straining while passing stools.
3.	Hold for 10 seconds (H10):	• Ask the patient to hold for 10 seconds compressing the thoracic and abdominal cavity, and then release the breath slowly.
❖ <b>Frequency &amp; duration:</b>	<ul style="list-style-type: none"> <li>• Repeat above 1,2,3 steps 10 times every hour for the first 5 hours</li> <li>• After completion of 5 hours, the patient can be allowed to sit upright</li> <li>• If symptoms persist, continue the same cycles for the next 2-3 hours</li> <li>• Allow patient to do this maneuver only in the daytime when awake and skip in the nighttime</li> </ul>	
❖ <b>Monitoring &amp; supervision:</b>	<ul style="list-style-type: none"> <li>• Monitor and supervise patient while doing this maneuver every time, at least for the first hour</li> <li>• Monitor vigilantly (vital parameters) in cardiac patients with ischemic heart disease or fixed output states</li> </ul>	
❖ <b>Avoid:</b>	<ul style="list-style-type: none"> <li>• Avoid in the patients who develop presyncope during this maneuver</li> <li>• Avoid in surgeries (abdominal or pelvic) where postoperative increased abdominal pressure is not allowed</li> <li>• Avoid in a patient with intracranial aneurysms – chances of its rupture during overshooting of blood pressure</li> <li>• Avoid in patients with chronic subdural hematomas - chances of rupture</li> </ul>	
<b>Possible hemodynamic fluctuations – associated physiology</b>		
❖ <b>Deep Inspiration</b>	<ul style="list-style-type: none"> <li>• Rise in BP (above baseline)</li> <li>• Fall in HR</li> </ul>	<ul style="list-style-type: none"> <li>• Early rise in intrathoracic pressure and mechanical factors (the compression of the aorta and propulsion of blood into peripheral circulation) cause a rise in BP</li> <li>• Increased vagal tone causes fall in HR</li> </ul>
❖ <b>Squeeze</b>	<ul style="list-style-type: none"> <li>• Fall in BP (below baseline)</li> </ul>	<ul style="list-style-type: none"> <li>• Increased transthoracic and transabdominal pressure causes a decrease in VR, SV, and thus BP</li> </ul>
❖ <b>Hold for 10 seconds</b>	<ul style="list-style-type: none"> <li>• Rise in HR</li> <li>• Rise in BP (back to baseline)</li> <li>• Rise in HR</li> </ul>	<ul style="list-style-type: none"> <li>• Fall in BP leads to a compensatory rise in HR</li> <li>• Baroreceptor activation</li> <li>• A sympathetically mediated rise in BP and HR</li> </ul>
❖ <b>Release of Hold</b>	<ul style="list-style-type: none"> <li>• Rise in BP (above baseline)</li> <li>• Fall in HR</li> </ul>	<ul style="list-style-type: none"> <li>• Blood refills pulmonary circulation</li> <li>• BP overshoot above baseline due to residual vasoconstriction</li> <li>• Baroreflex mediated bradycardia</li> </ul>

PDPH: Postdural Puncture Headache, BP: Blood Pressure, HR: Heart Rate

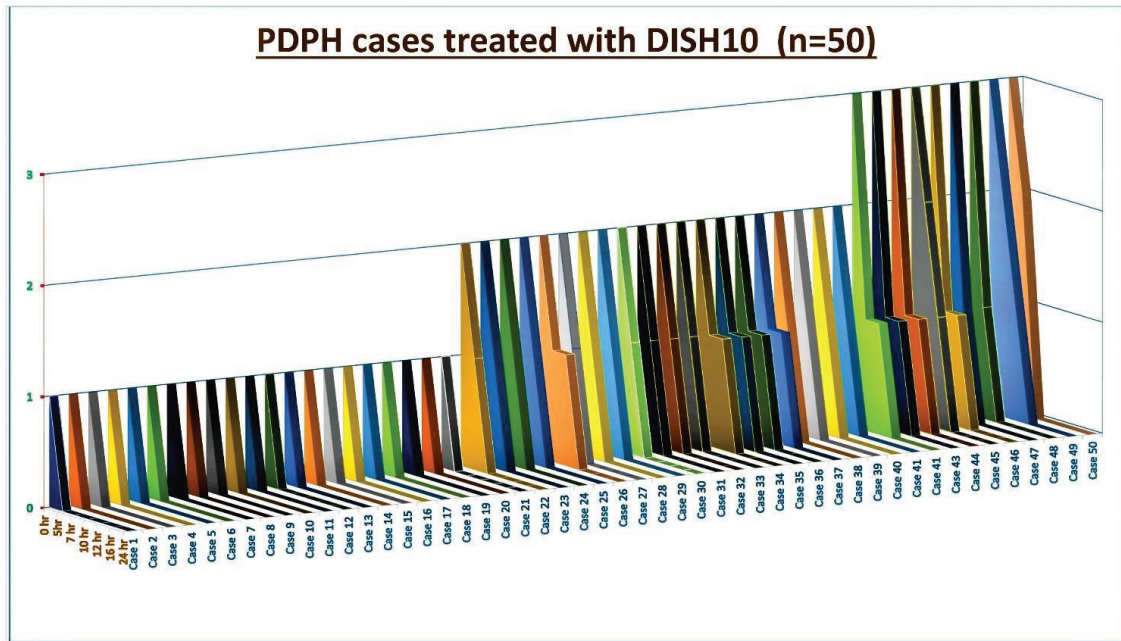


Figure 1: Severity of the PDPH cases treated with DISH10 maneuver at various time intervals.

### Outcome measurement

The patient’s demographics, type of neuraxial anesthesia, size/type of spinal needle, and the onset and severity of the PDPH symptoms were noted (Table 2). The outcomes were measured about the effect of spinal needle size/type to develop PDPH, time to develop PDPH (headache freedom time), treatment duration or time to outcome (time to become symptoms-free), and the effect of headache severity on time to outcome.

### Statistical analysis

Data were coded and recorded in the MS Excel spreadsheet program and statistically analyzed (Table 3) using IBM SPSS statistics (Statistical Package for Social Sciences, software version 23.0, IBM Corp., Chicago, USA). Descriptive statistics were elaborated in means/standard deviations and medians/IQRs for continuous variables, frequencies, and percentages for categorical variables. Data were presented graphically (Figures 2-4) wherever appropriate for data visualization using histograms/box-and-whisker plots/column charts for continuous data and bar charts/pie charts for categorical data. When comparing two groups, the independent sample ‘t’ test was used for continuously distributed data. For non-normally distributed data, appropriate nonparametric tests like the Wilcoxon Test were used. A chi-squared test was used for group comparisons for categorical data. Fisher’s Exact Test was used if the expected frequency in the contingency tables was found to be <5 for >25% of the cells. Linear correlation between two continuous variables was explored using Pearson’s correlation (if the data were normally distributed) and Spearman’s correlation (for non-normally distributed data). Statistical significance was kept at p < 0.05.

Table 2: Demographic chart of comparative cohort study.

Parameters	Group		p-value
	Group 1 (n = 50)	Group 2 (n = 50)	
<b>Age (Y ears)</b>			
Age distribution	34.26 ± 12.28	36.50 ± 11.57	0.350 <sup>1</sup>
≤20 Years	8 (16.0%)	2 (4.0%)	
21-30 Years	14 (28.0%)	14 (28.0%)	
31-40 Years	11 (22.0%)	19 (38.0%)	
41-50 Years	11 (22.0%)	9 (18.0%)	
51-60 Years	6 (12.0%)	5 (10.0%)	
61-70 Years	0 (0.0%)	1 (2.0%)	
<b>Gender</b>			
Male	28 (56.0%)	30 (60.0%)	0.685 <sup>2</sup>
Female	22 (44.0%)	20 (40.0%)	
<b>ASA Grade</b>			
I	42 (84.0%)	41 (82.0%)	0.790 <sup>2</sup>
II	8 (16.0%)	9 (18.0%)	
<b>Severity of PDPH</b>			
Mild	21 (42.0%)	15 (30.0%)	0.441 <sup>2</sup>
Moderate	20 (40.0%)	23 (46.0%)	
Severe	9 (18.0%)	12 (24.0%)	
<b>Time to PDPH Onset (Hours)***</b>			
	73.14 ± 24.74	57.72 ± 28.35	0.002 <sup>3</sup>
<b>Type of Neuraxial Anesthesia</b>			
SAB	37 (74.0%)	32 (64.0%)	0.280 <sup>2</sup>
CSEA	13 (26.0%)	18 (36.0%)	
<b>Type of Spinal Needle</b>			
25G	41 (82.0%)	37 (74.0%)	0.334 <sup>2</sup>
27G	9 (18.0%)	13 (26.0%)	
<b>PDPH Severity (24 Hours)***</b>			
	0.00 ± 0.00	0.46 ± 0.50	<0.001 <sup>3</sup>
<b>Time to Outcome (Hours)***</b>			
	6.82 ± 1.92	48.40 ± 19.42	<0.001 <sup>3</sup>

\*\*\*Significant at p<0.05, 1: t-test, 2: Chi-Squared Test, 3: Wilcoxon-Mann-Whitney U Test

**Table 3:** Statistical analysis of comparison between Group 1 and Group 2.

Parameters	Observations
<b>1. Comparability of both groups:</b>  <b>Test used:</b> • t-test • Chi-squared test	<ul style="list-style-type: none"> <li>The demographic profile was comparable for both groups.</li> <li>No significant difference found between both the groups in terms of               <ul style="list-style-type: none"> <li>✦ age (years) (<math>t = -0.939</math>, <math>p = 0.350</math>)</li> <li>✦ distribution of Age (<math>\chi^2 = 7.024</math>, <math>p = 0.219</math>)</li> <li>✦ distribution of gender (<math>\chi^2 = 0.164</math>, <math>p = 0.685</math>)</li> <li>✦ distribution of ASA grade (<math>\chi^2 = 0.071</math>, <math>p = 0.790</math>)</li> <li>✦ distribution of type of spinal needle (<math>\chi^2 = 0.932</math>, <math>p = 0.334</math>)</li> <li>✦ distribution of type of neuraxial anesthesia (<math>\chi^2 = 1.169</math>, <math>p = 0.280</math>)</li> </ul> </li> </ul>
<b>2. Effect of spinal needle type/size:</b>	<ul style="list-style-type: none"> <li>The incidence of PDPH was higher with 25G spinal needles (Quincke) in both the groups (82% in DISH10 and 74% in Group 2) than with 27G spinal needles (Whitacre).</li> <li>Time to outcome (treatment duration) was significantly less in the DISH10 group (5-10 hours) for both the needle compared to Group 2 (20-96 hours for 25 G and 26-100 hours for 27 G)</li> <li>However, the time to outcome (hours) in both groups remained unaffected due to the needle type and size.</li> </ul>
<b>3. Headache freedom:</b>  <b>Test used:</b> • Wilcoxon-Mann Whitney U Test • Spearman Correlation Coefficient	<ul style="list-style-type: none"> <li>A significant difference was found between the two groups in Time to PDPH onset (<math>W = 1689.000</math>, <math>p = 0.002</math>), with the median Time to PDPH onset being highest in Group 1.</li> <li>We found a moderate positive and statistically significant (<math>\rho = 0.37</math>, <math>p = 0.008</math>) correlation between headache freedom time and treatment duration in Group 1.</li> <li>In contrast, it was a weak negative and statistically insignificant (<math>\rho = -0.17</math>, <math>p = 0.227</math>) in Group 2.</li> <li>For every 1 unit increase in time to PDPH onset (hours), the time to outcome (hours) increases by 0.03 units.</li> </ul>
<b>4. Treatment duration:</b>  <b>Test used:</b> Wilcoxon-Mann-Whitney U Test	<ul style="list-style-type: none"> <li>The median time to outcome (in hours) in               <ul style="list-style-type: none"> <li>✦ Group 1 (DISH10 group) was 7 (5-7)</li> <li>✦ Group 2 was 48 (28.5-52) with 48 (26-50) in the SPGB subgroup, 48 (36-60) in the conservative only group.</li> </ul> </li> <li>A significant difference was found between the two groups in terms of treatment duration (<math>W = 0.000</math>, <math>p = &lt;0.001</math>), with the median duration (hours) being highest in Group 2.</li> <li>Thus, the time required to make the patient symptom-free with the DISH10 maneuver was significantly lower (5-10 hours) than the conservative group (2080 hours with SPGB and 24-100 hours with conservative only).</li> </ul>
<b>5. Effect of PDPH severity on time to outcome:</b>  <b>Test used:</b> Chi-squared test	<ul style="list-style-type: none"> <li>There was a significant difference between headache severity grades in terms of time to outcome (hours). [Group 1 (<math>\chi^2 = 42.453</math>, <math>p = &lt;0.001</math>) and Group 2 (<math>\chi^2 = 41.213</math>, <math>p = &lt;0.001</math>)]</li> <li>The median time to outcome (in hours) for               <ul style="list-style-type: none"> <li>✦ Mild headache was 5 (5-5) for the case group and 26 (26-28) for the control group.</li> <li>✦ Moderate headache was 7 (7-7.75) for the case group and 48 (48-50) for the control group.</li> <li>✦ Severe headache was 10 (7-10) for the case group and 72 (69-81)</li> </ul> </li> <li>Thus, the median time to outcome (hours) was significantly highest in severe PDPH in both groups.</li> </ul>

(**t**: t-test,  **$\chi^2$** : Chi-squared test, **W**: Wilcoxon-Mann-Whitney U Test,  **$\rho$** : Spearman Correlation Coefficient)

## Results

Out of 117 patients included in this comparative cohort study, 57 patients were enrolled in Group 1 (prospective case series) and 60 patients in Group 2 (retrospective cohort). Out of 57 patients in Group 1 (DISH10 group), seven patients were excluded due to failure to complete steps as per instructions (4 patients) and delay in treatment due to nighttime (3 patients). Out of 60 patients in Group 2 (conservative group), ten patients were excluded due to incomplete and misleading data in their case sheets. In this comparative cohort study,

- The most common age of presentation of PDPH was in the age group of 11-64 years. The median (IQR) of age (years) in the Group 1 was 32.5 (24-43.75), and Group 2 was 35 (27.25-44.25).
- 58% of the PDPH patients were males, whereas 42% were females.
- 83 (83%) patients (42 in Group 1 and 41 in Group 2) were of ASA I grade, and 17 (17%) patients (8 in Group 1 and 9 in Group 2) of ASA II grade.
- 69 (69%) patients (37 in Group 1 and 32 in Group 2)

received SAB, whereas 31(31%) patients (13 in Group 1 and 18 in Group 2) received CSEA.

- The spinal needle used in 78 (78%) patients (41 in Group 1 and 37 in Group 2) was 25G of Quincke type, and in 22 (22%) patients (9 in Group 1 and 13 in Group 2) was 27 G of Whitacre type.
- The headache severity of 36 (36%) patients (21 in Group 1 and 15 in Group 2) was mild, 43 (43%) patients (20 in Group 1 and 23 in Group 2) was moderate, and 21 (21%) patients (9 Group 1 and 12 in Group 2) was severe.
- The time to PDPH onset or headache freedom time (hours) in Group 1 ranged from 24- 129, and Group 2 ranged from 18 - 138. The median (IQR) of time to PDPH onset (hours) in the Group 1 was 72 (53.5-92), and Group 2 was 51.5 (39.75-70.75).
- The time to outcome (hours) in Group 1 ranged from 5-10, and in Group 2 ranged from 20-100. The median (IQR) of time to outcome (hours) in the Group 1 was 7 (5-7), and Group 2 was 48 (28.5-52).
- The time to outcome (time required to make patient symptom-free/treatment duration) in the patients with severe grade headache was more than others.

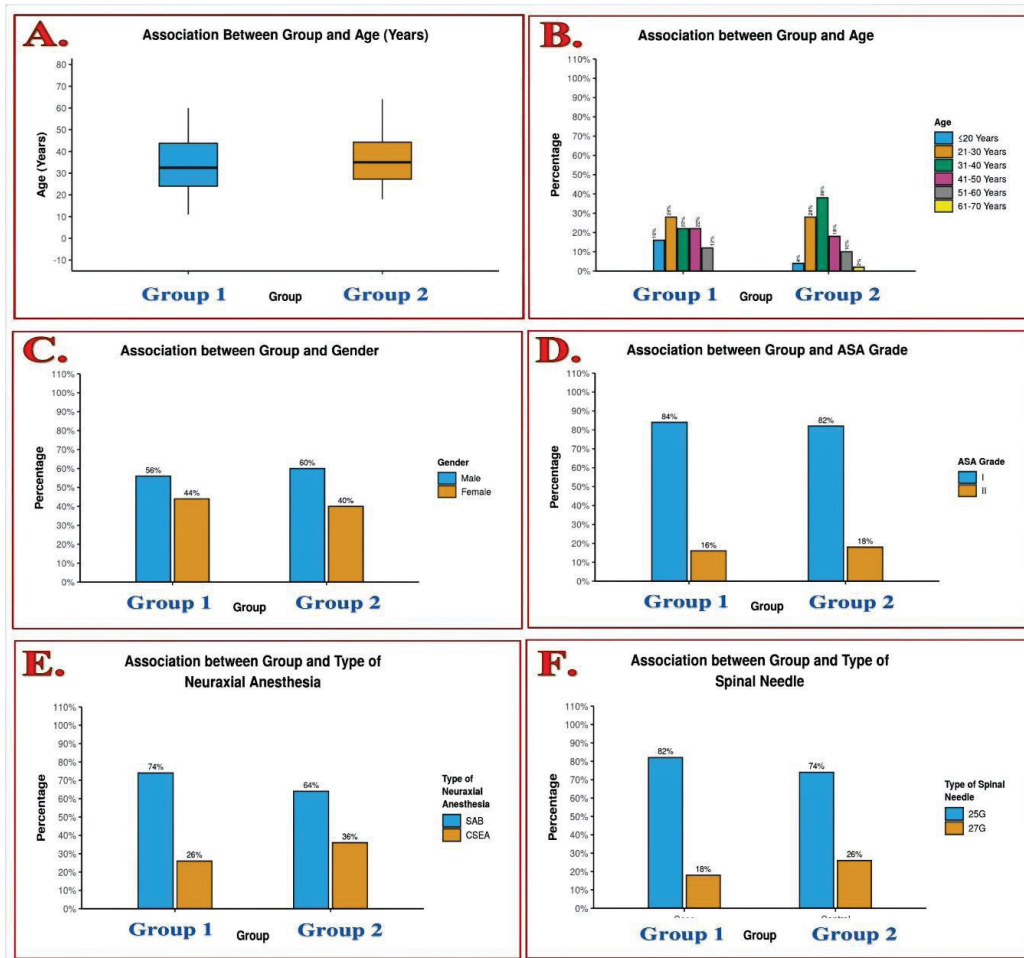


Figure 2: Comparability of the groups.

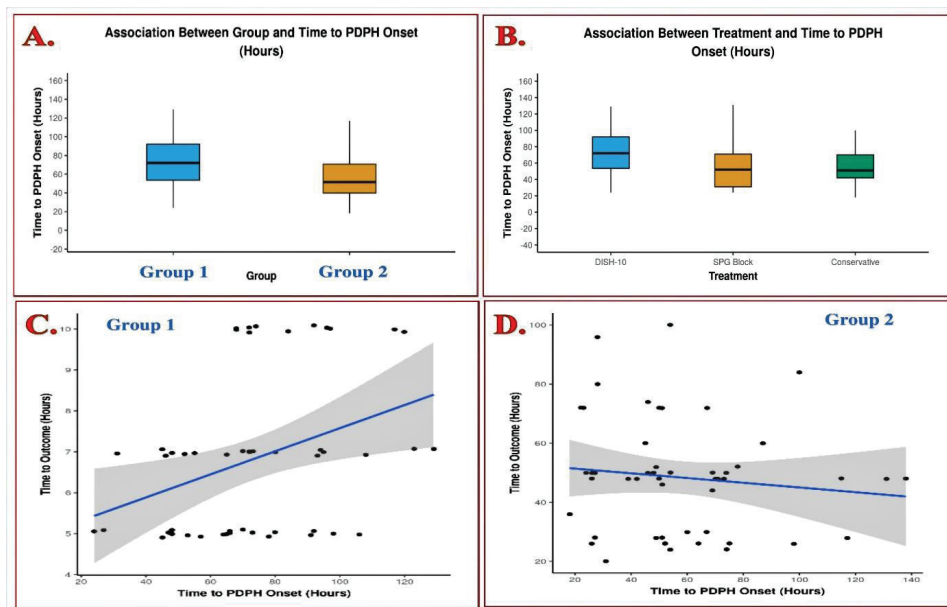


Figure 3: Comparison of headache freedom time between groups.

A. & B.:The Box-and-Whisker plot depicts the distribution of Time to PDPH Onset (hours) in the two groups.

The middle horizontal line represents the median Time to PDPH Onset (hours), the upper and lower bounds of the box represent the 75th and the 25th centile of Time to PDPH Onset (hours) respectively, and the upper and lower extent of the whiskers represent the Tukey limits for Time to PDPH Onset (hours) in each of the groups.

C. & D: The scatterplot depicts the correlation between Time to PDPH Onset (hours) and Time to Outcome (hours).

Individual points represent individual cases. The blue trendline represents the general trend of correlation between the two variables. The shaded grey area represents the 95% confidence interval of this trendline.

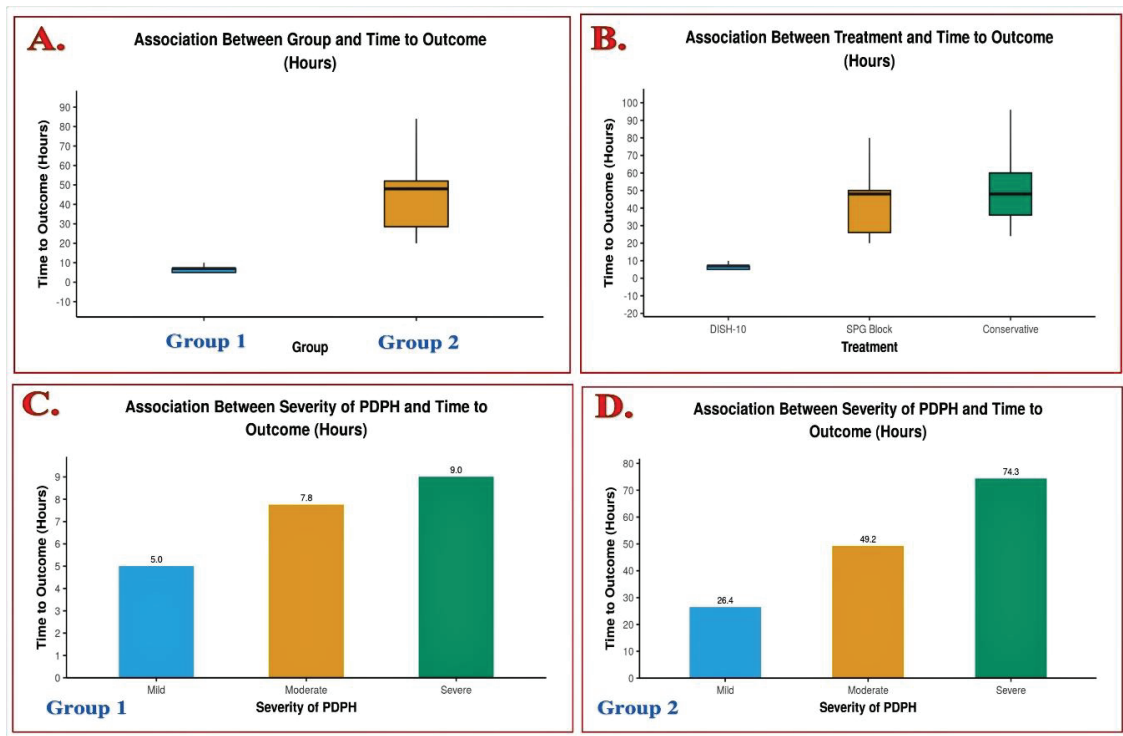


Figure 4: Comparison of treatment duration (time to outcome) between groups.

## Discussion

The findings of our comparative cohort study support our hypothesis and suggest that PDPH patients treated with the DISH10 maneuver will experience quick symptomatic relief due to faster spontaneous recovery. The cohort of prospective case series (Group 1) demonstrates an alternative to invasive procedures for PDPH with a high success rate within 24 hours of therapy. Comparing this group with the retrospective cohort (Group 2) evinced reduced time to outcome (treatment duration), making patients ready to discharge. Other findings like the occurrence of PDPH commonly in the younger population (median age in years of Group 1 is 32.5, and Group 2 is 35) and its association with large-bore needles (78% with 25 G Quincke-type and 22% with 27 G Whitacre-type) are consistent with available literature of PDPH [7-13].

The DISH10 maneuver is self-controlled (without the requirement of any extra person), non-invasive (without the need of any invasive procedure or specialized instrument or drug), and a cost-effective (early discharge and less hospital stay) option for PDPH management. However, this intervention involves a specialized maneuver that helps in increasing intrathoracic and intraabdominal pressure at high-frequency intervals. The rationale for a favorable outcome with this technique is multifactorial. The knowledge of PDPH etiopathogenesis is essential to understand the mechanism of the DISH10 maneuver.

The etiopathogenesis of PDPH includes CSF leakage from the subarachnoid space (through the meningeal puncture), resulting in disruption of CSF homeostasis due to a decrease in CSF volume and pressure [14]. The CSF is produced

primarily in the choroid plexus at a rate of approximately 0.20-0.35 mL/min (around 25 ml/hr or 500 ml/day) and reabsorbed through the arachnoid villi [15]. At any moment, the total CSF volume in adults is maintained at around 125-150 mL, of which approximately half is extracranial [16]. Loss of approximately 10% of total CSF volume predictably results in the development of typical PDPH symptoms, which resolve promptly with the reconstitution of this deficit [17]. Concurrent intracranial hypotension due to persistent CSF leak may lead to adenosine-mediated cerebral and meningeal vasodilation, which may cause or contribute to the headache [18]. Thus, the headache following CSF hypotension develops due to a bimodal mechanism involving both loss of intracranial support (buoyant support) and reciprocal cerebral vasodilation (predominantly venous) [13]. Diminished buoyant support results in radiologically demonstrable 'sagging' of intracranial structures mainly in the upright position, resulting in traction and pressure on pain-sensitive structures (dura, cranial nerves, bridging veins, and venous sinuses) within the cranium [13]. The stretching of various neural elements causes typical symptoms of PDPH like positional headache, nuchal pain, and other associated auditory/visual/vestibular symptoms (Table 4).

The anatomical and physiological factors of the neuraxis affect the closure of dural holes and CSF leakage. The epidural space is considered a potential space with negative pressure ranging from -1 cm H<sub>2</sub>O (lumbar region) to -10 cm H<sub>2</sub>O (thoracic region). The measured CSF pressure via lumbar puncture is 10-18 cm H<sub>2</sub>O (8-15 mmHg or 1.1-2 kPa) in the lateral position and 20-30 cm H<sub>2</sub>O (16-24 mmHg or 2.1-3.2 kPa) in the sitting position [19]. The negative epidural pressure and the positive subarachnoid pressure create a high-pressure

**Table 4:** Symptomatology of postdural puncture headache.

Postdural puncture headache
Characteristics of headache in PDPH are, <ul style="list-style-type: none"> <li>• Bilateral (frontal, occipital, or both)</li> <li>• Worsening in the upright position, relieved/improved with recumbency.</li> <li>• Dull/aching, throbbing, or pressure type</li> <li>• The onset usually within 12–48 hours to rarely more than 5 days.</li> </ul>
Associated Symptoms and Neural Pathophysiology
<ul style="list-style-type: none"> <li>• Frontal pain - Ophthalmic branch of the trigeminal nerve (CN V)</li> <li>• Neck and shoulder pain- C1-C3</li> <li>• Nausea and vomiting- Vagus nerve (CN X)</li> <li>• Visual disturbances - Transient palsy of CN III, IV, and VI</li> <li>• Auditory and vestibular symptoms- Facial (CN VII) and auditory (CN VIII) nerves</li> </ul>
<b>CN:</b> Cranial nerve

gradient across the dural opening, resulting in a continuous suctioning effect leading to persistent CSF drainage. This vacuum effect may impede the spontaneous closure of the dural hole and cause a massive CSF collection outside the dura.

Factors modifying negative epidural pressure include the head-up position, cough, Valsalva, Queckenstedt, and abdominal wall compression maneuvers [20]. Moreover, at the lumbar level, the 30% head-up position decreases the epidural pressure to half that at the supine position [21]. The Valsalva maneuver (VM) and cough cause increased epidural pressure in the cervical, thoracic, and lumbar areas. The abdominal compression binder mainly increases transabdominal pressure. The VM is one of the vagal maneuvers described mainly for restoring heart rhythm, diagnosing autonomic disorders, and treating clogged ears. There is a subtle difference between VM and DISH10 maneuver. The VM is a “forced expiration against a closed glottis,” leading to a decrease in thoracic cavity volume at the end of expiration, which causes ineffective pressure generation to increase the epidural blood flow. In contrast, the DISH10 is a “deep inspiratory hold” combined with squeezing (chest and abdomen), increasing intrathoracic and intra-abdominal pressure simultaneously. These changes in the visceral cavity pressures can be transmitted to the epidural space directly, generating and maintaining sufficient pressure to engorge the epidural venous plexus (Figure 5).

So, the DISH10 maneuver is based on the principle of generating adequate transthoracic and transabdominal pressure to be effective in increasing the blood flow in the epidural venous plexuses (Figure 6). The resulting engorgement of the epidural veins produces an external “tamponade effect” that may compress long dural segments, mainly in the lumbosacral region (dependent area). Compression of the dural segment pushes the CSF back into the calvarium, correcting the intracranial CSF hypotension. This tamponade effect also reverses the pressure gradient across the dura, stopping the CSF leakage. We believe that an epidural blood patch also creates a similar tamponade effect over the lumbosacral region resulting in a similar effect (pushing the CSF back into the calvarium), causing quick relief from the symptoms.

Maintaining the positive epidural pressure for a significant duration reverses dural drag/stretch, allows new CSF formation

to replace lost volume without any further leakages, and restores CSF homeostasis. The epidural pressure peaks up to +60 cm H<sub>2</sub>O after the epidural saline injection and fell exponentially to zero within 10 minutes [22]. Thus, to maintain continuous epidural pressure, we kept the DISH10 maneuver frequency as ten cycles per hour, keeping a gap of at least six minutes between them. This continuous external pressure on the dura may also keep ends of the dural hole approximated and align the arachnoid stretch, potentially leading to complete closure of the meningeal defect that allows it to heal spontaneously.

The ideal non-invasive techniques should serve three purposes. Firstly, it should reverse the pressure gradient across the dural hole to stop CSF leakage by creating positive pressure in the negative epidural space. Secondly, it should correct the intracranial CSF hypotension by pushing the CSF back into the calvarium. Thirdly, it should immediately improve PDPH symptoms by correcting the brain sagging and dural stretching/dragging. Thus, the DISH10 maneuver fulfills all three essential purposes making it the most effective adjunct to the conservative treatment.

Transient increase in the transthoracic and transabdominal pressure in this maneuver may cause hemodynamic fluctuations (Table 1). A significant decrease in the cerebral perfusion pressure (CPP) has been demonstrated during the strain phase [23] due to an abrupt reduction in mean arterial pressure (MAP). It can result in syncope due to an acute reduction in cerebral oxygenation leading to unconsciousness. For this reason, we believe in avoiding this maneuver in patients with contraindications to traditional vagal maneuvers or in patients who develop presyncope with this maneuver. Fortunately, such complications were not seen in all our patients. The patient’s position has a modest effect, with a more considerable decrease in BP during the squeezing phase with the patient seated or standing (and a greater risk of syncope) [24]. As a precaution, we recommend doing this maneuver in a lying-down position with raised (15–20 degree) foot end of the bed to maintain venous return and avoid syncopal attacks. The patient should not be allowed to sit before 5 hours of treatment.

The possibility of hemodynamic fluctuation necessitates vigilant monitoring (of vital parameters) in patients with cardiac issues (like ischemic heart disease or fixed cardiac output states) during the performance of DISH10. However, we found it safe and effective in such populations without any complications. The patients with a high body mass index (i.e., obesity) may have a decreased risk of developing PDPH, possibly secondary to a beneficial effect of increased intra-abdominal pressure [25]. The clinicians should be well conversant with its applied physiology and use it judiciously to avoid associated complications.

Most of the treatments of PDPH mainly focus on either stoppage of CSF leakage or correcting intracranial CSF hypotension. These treatments include oral/intravenous fluids and analgesics, caffeine, 5-HT receptor antagonist, and most importantly, the epidural blood patch (EBP). The EBP technique, though considered a gold standard treatment, is an invasive procedure and not free of side effects. It is presumed to act by



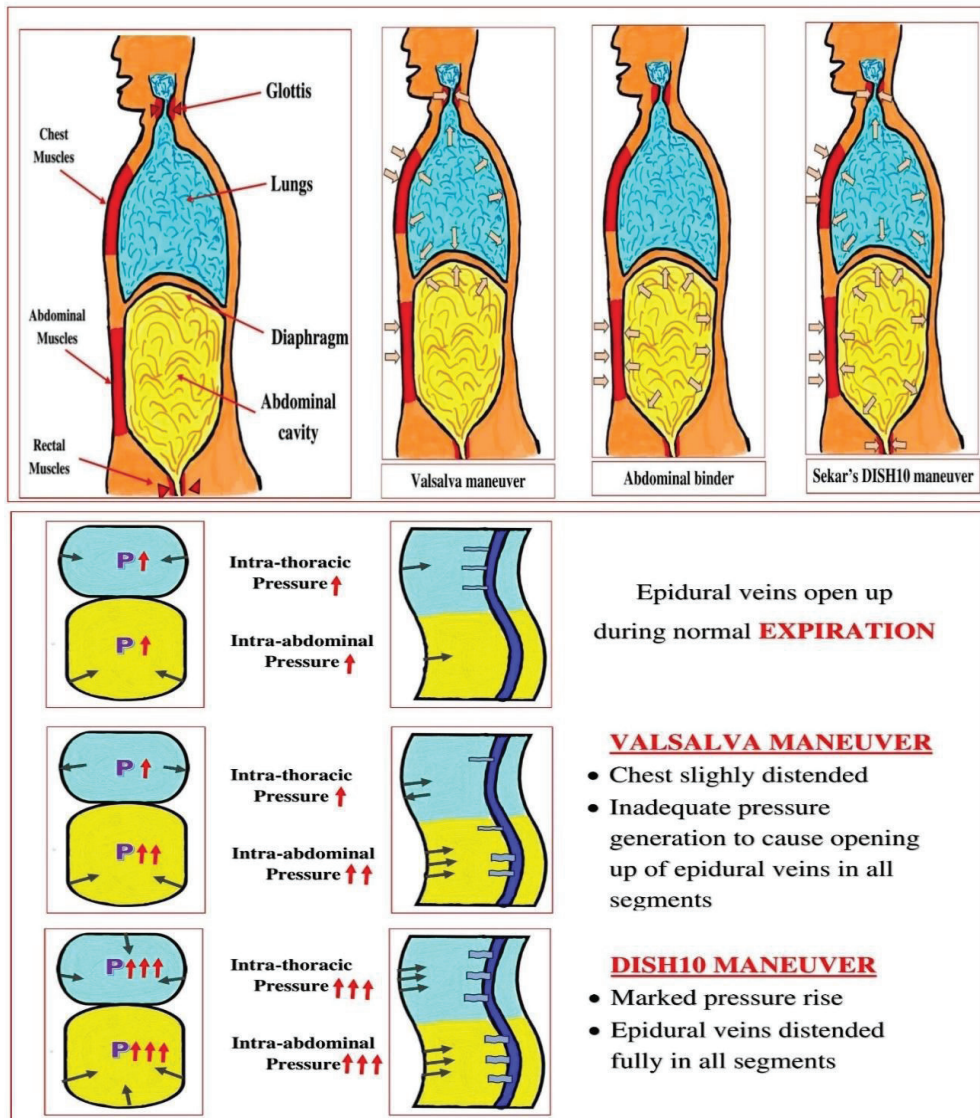


Figure 5: Schematic diagram showing intrathoracic and intra-abdominal pressure changes in various maneuvers and a DISH10 maneuver.

sealing the dural hole and stopping CSF leakage. Bed rest is also an essential component of conservative management, as lying down position shifts CSF back into calvarium, correcting CSF hypotension and improving symptoms. Due to the paucity of quality literature, many questions regarding treatment options of PDPH are still unanswered. However, spontaneous recovery is possible in PDPH patients without any treatment in 4-5 days. In 70%, the headache resolves in a week, and in 87% of cases, it resolves within six months [26] or longer than six months [27]. Severe PDPH can cause delayed recovery and discharge from the hospital, which adds to the treatment cost. The patients in Group 1 (case series) had improvement in symptoms within 24 hours of starting the maneuver, which further avoided a delay in discharge and thus reduced total hospital stay. Thus, by causing faster relief of PDPH symptoms through a probable sealant effect and tamponade effect described before, the DISH10 maneuver aids spontaneous recovery.

The limitation of our study is its design and limited sample size. We did not include other subgroups of patients like

pregnant ladies or children in this study. We have not evaluated the efficacy of DISH10 in patients with PDPH following diagnostic lumbar puncture or myelography. Moreover, a prospective randomized case-control trial would have produced a better level of evidence and lesser bias.

### Conclusions

PDPH has become a rare complication due to advances in anesthesia techniques, improved knowledge of pathophysiology, and the implementation of preventable measures. Diagnosis and treatment options of PDPH depend on its presentation as well as the severity of symptoms. Spontaneous recovery from the PDPH is directly proportional to the severity of the symptoms.

The non-invasive DISH10 maneuver promotes enhanced recovery from the PDPH. It may be a safer alternative in the PDPH management over the other invasive interventions due to its better side-effect profile, noninvasiveness, and cost-

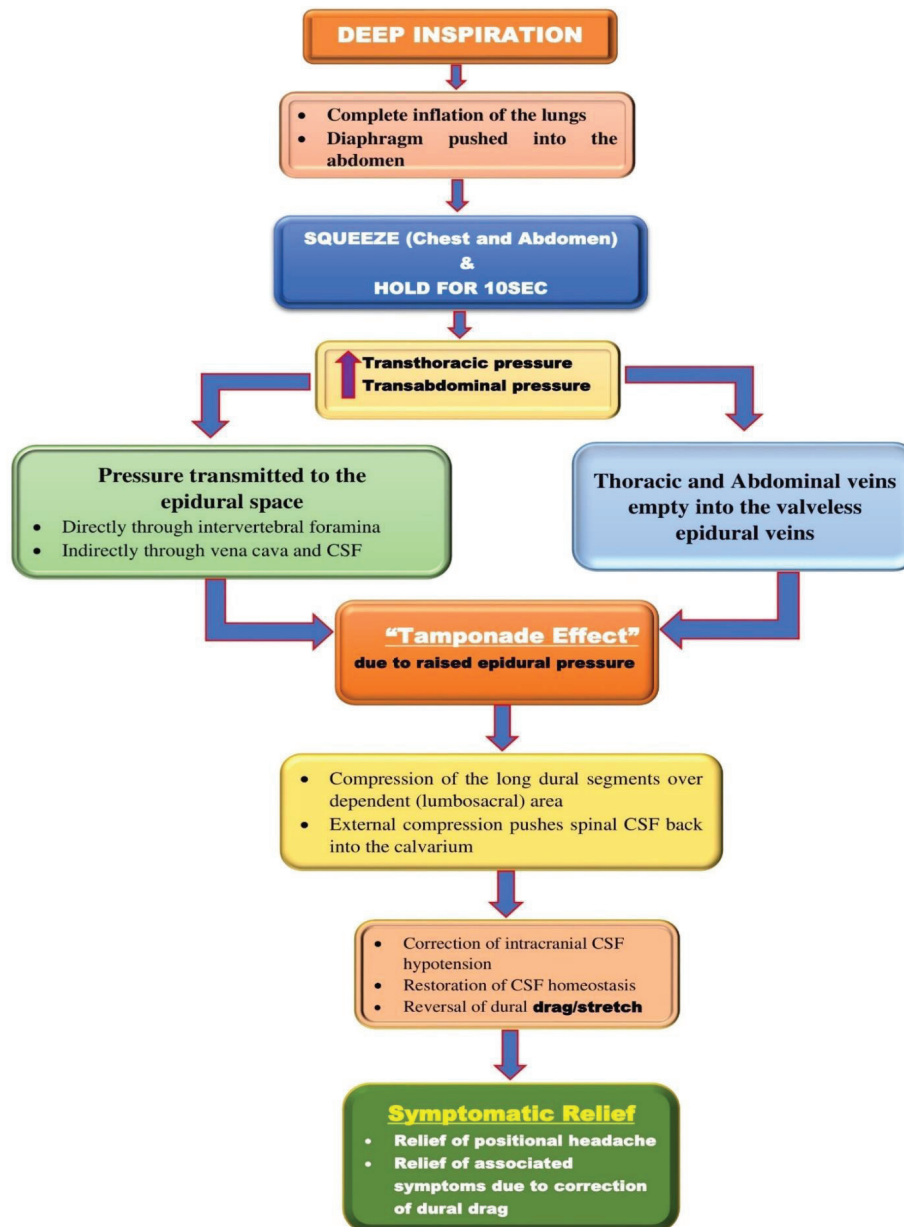


Figure 6: Mechanism of DISH10 maneuver.

effectiveness. However, well-designed prospective comparative clinical investigations with a larger sample size are warranted to validate these findings, beliefs and speculations.

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## Contributorship Statement

K.S: Involved in the conceptualization of the technique developed by CS. Coined term Sekar's DISH10 maneuver. Involved in implementing treatment protocol in cases included. Involved in reference collection and sorting work with the help of HD and TM. Designed manuscript content and co-wrote the

paper. Took the lead in manuscript writing and illustration compilation.

C.S: Major contributor in developing and innovating DISH10 maneuver. Provided scientific guidance for manuscript writing as well as essential content for the conceptualization of the idea. Guided the content of the manuscript and co-wrote the paper. The approved final version of the manuscript.

H.D: Involved in the anatomical description and information collection required for the manuscript writing. Co-wrote and proofread the manuscript.

T.M: Provided clinical data required for the manuscript writing. Co-wrote and proofread the manuscript.

All authors provided critical feedback and helped shape the manuscript.



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