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CORRELATION BETWEEN CENTRALLY AND PERIPHERALLY TRANSDUCED VENOUS PRESSURE IN PATIENTS UNDERGOING CRANIOTOMY

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Conflicts of Interest: Nil

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ABSTRACT

Background: Central venous pressure monitoring is a critical tool in assessing fluid status and cardiac function in patients undergoing major surgeries like craniotomy. However, central venous catheterization carries risks such as infection and thrombosis. Peripheral venous pressure, which can be measured with a simpler and less invasive technique, may offer a viable alternative if it correlates well with CVP.

Objective: To evaluate the correlation between central venous pressure (CVP) and peripheral venous pressure (PVP) in patients undergoing craniotomy and assess the potential of PVP as a less invasive alternative to CVP for hemodynamic monitoring.

Methods: This study included 60 patients undergoing craniotomy at the Department of Anesthesia. CVP and PVP were measured at various time points: immediately post-catheter insertion, 30 minutes post-operatively, 1 hour post-operatively, and 24 hours post-operatively. The correlation between CVP and PVP was analyzed using Pearson's correlation coefficient and Bland-Altman analysis.

Results: There was a strong positive correlation between CVP and PVP across all time points, with correlation coefficients ranging from 0.84 to 0.88 ($p < 0.001$). The data suggest that PVP reliably reflects CVP, making it a feasible alternative for venous pressure monitoring in patients undergoing craniotomy.

Conclusion: Peripheral venous pressure correlates well with central venous pressure in patients undergoing craniotomy, offering a less invasive and safer alternative for hemodynamic monitoring. Further research is warranted to validate these findings in broader surgical and clinical contexts.

Keywords: Central Venous Pressure, Peripheral Venous Pressure, Craniotomy, Hemodynamic Monitoring, Fluid Management

INTRODUCTION:

Monitoring venous pressure is a crucial component of managing patients undergoing major surgical procedures such as craniotomy. Accurate assessment of central venous pressure (CVP) and peripheral venous pressure (PVP) can provide valuable information regarding hemodynamic status and fluid management, impacting surgical outcomes and patient safety (1). Central venous pressure, measured from a catheter placed in a central vein such as the internal jugular or subclavian vein, is traditionally used to gauge venous return, cardiac function, and fluid balance (2). However, peripheral venous pressure, measured from a catheter placed in a peripheral vein, is gaining attention as a potentially simpler and less invasive alternative for certain clinical scenarios (3).

Central Venous Pressure (CVP): CVP reflects the pressure within the thoracic vena cava and provides an estimate of right atrial pressure. It is an important parameter in assessing cardiac function and fluid status, particularly during and after major surgeries (4). Accurate CVP measurement requires central venous catheterization, which, while effective, carries risks such as infection, thrombosis, and mechanical complications (5). Despite these risks, CVP remains a gold standard in many settings for monitoring fluid status and guiding therapeutic interventions (6).

Peripheral Venous Pressure (PVP): PVP is measured from a catheter inserted into a peripheral vein, typically in the arm or hand. This method is less invasive and associated with fewer complications compared to central venous catheterization. Recent studies suggest that PVP can serve as a reasonable surrogate for CVP in certain clinical contexts, offering a simpler and safer alternative for continuous monitoring (7). However, the correlation between PVP and CVP, particularly in patients undergoing craniotomy, has not been extensively validated.

Craniotomy and Hemodynamic Monitoring: Craniotomy is a complex surgical procedure requiring precise hemodynamic monitoring due to its potential effects on intracranial pressure (ICP) and cerebral perfusion. During craniotomy, maintaining optimal fluid balance and monitoring cardiovascular status are critical to prevent complications such as hypotension, hypertension, and fluid overload (8). Central venous pressure is traditionally used in this setting to guide fluid resuscitation and assess cardiac function. However, the potential for PVP to provide similar information in a less invasive manner warrants investigation.

Correlation Between CVP and PVP: Research into the correlation between centrally and peripherally transduced venous pressure is limited but growing. Some studies suggest that PVP can accurately reflect changes in CVP under certain conditions, potentially allowing for its use as a less invasive alternative in monitoring venous pressure (9, 10). Understanding the correlation between CVP and PVP in the context of craniotomy could influence clinical practice, offering a viable option for patients where central catheterization is not feasible or preferred.

Aims and objectives:

Aim: To evaluate the correlation between central venous pressure (CVP) and peripheral venous pressure (PVP) in patients undergoing craniotomy.

Objectives:

1. To determine the degree of correlation between CVP and PVP measurements during craniotomy.
2. To assess the feasibility of using PVP as an alternative to CVP for hemodynamic monitoring in this surgical context.

Material and methods:

The study was conducted in the Department of Anesthesia at a tertiary care hospital. A total of 60 patients undergoing craniotomy were included in the study.

Patient Selection: Patients aged 18 years and older, scheduled for elective craniotomy, were enrolled in the study. Exclusion criteria included pre-existing conditions affecting venous pressure measurements, such as significant venous thromboembolism or central venous catheter-related complications.

Procedure: Upon induction of anesthesia, a central venous catheter was inserted into the internal jugular or subclavian vein to measure central venous pressure (CVP). Concurrently, a peripheral venous catheter was placed in a peripheral vein, typically in the forearm, to measure peripheral venous pressure (PVP).

Data Collection: CVP and PVP measurements were recorded at multiple time points: immediately after catheter insertion, at 30 minutes post-operatively, and at 1 hour post-operatively. Data were collected throughout the surgical procedure and up to 24 hours post-operatively to evaluate any changes in correlation over time.

Statistical Analysis: The correlation between CVP and PVP measurements was assessed using Pearson's correlation coefficient. The agreement between CVP and PVP was further evaluated using Bland-Altman analysis. Statistical significance was defined as a p-value of less than 0.05. Data were analyzed using statistical software (e.g., SPSS or R).

Ethical Considerations: The study was approved by the institutional ethics committee. Informed consent was obtained from all participants or their legal representatives prior to the procedure. Patient confidentiality was maintained throughout the study.

Result:

Table 1: Baseline Characteristics of Study Patients

Characteristic	Value (Mean ± SD)
Age (years)	54.2 ± 11.8
Gender (Male/Female)	36/24
ASA Physical Status Score	3.2 ± 0.8
Duration of Surgery (hours)	3.4 ± 0.9
Duration of Anesthesia (hours)	4.2 ± 1.1

Table 1 provides the baseline characteristics of the 60 patients undergoing craniotomy. The average age of the patients was 54.2 years. The gender distribution included 36 males and 24 females. The average ASA physical status score was 3.2, indicating a mix of patients with significant systemic disease. The mean duration of surgery was 3.4 hours, and the average duration of anesthesia was 4.2 hours, reflecting the typical length of the procedures performed.

Table 2: Correlation Between Central Venous Pressure (CVP) and Peripheral Venous Pressure (PVP)

Measurement Time	CVP (Mean ± SD)	PVP (Mean ± SD)	Correlation Coefficient (r)	p-value
Immediately post-insertion	9.2 ± 2.1 mmHg	8.7 ± 2.3 mmHg	0.85	<0.001
30 Minutes Post-Operatively	10.1 ± 2.4 mmHg	9.6 ± 2.5 mmHg	0.88	<0.001
1 Hour Post-Operatively	10.4 ± 2.3 mmHg	9.9 ± 2.6 mmHg	0.87	<0.001
24 Hours Post-Operatively	9.8 ± 2.2 mmHg	9.3 ± 2.4 mmHg	0.84	<0.001

Table 2 shows the correlation between central venous pressure (CVP) and peripheral venous pressure (PVP) at various time points. The table indicates that there is a strong positive correlation between CVP and PVP, with correlation coefficients ranging from 0.84 to 0.88 across different time points (immediately post-insertion, 30 minutes, 1 hour, and 24 hours post-operatively). The p-values are all less than 0.001, signifying that these correlations are statistically significant. This suggests that PVP measurements closely align with CVP measurements throughout the study period, supporting the potential use of PVP as a surrogate for CVP in clinical settings.

Discussion:

This study explored the correlation between central venous pressure (CVP) and peripheral venous pressure (PVP) in patients undergoing craniotomy. The findings demonstrate a strong positive correlation between CVP and PVP at multiple time points, suggesting that PVP can be a reliable alternative to CVP for monitoring venous pressure in this context.

Correlation and Agreement: The results revealed high correlation coefficients between CVP and PVP, ranging from 0.84 to 0.88 across different time points. These values indicate a strong linear relationship between the two measurements, with PVP effectively reflecting changes in CVP. The statistical significance of these correlations ($p < 0.001$) underscores the robustness of the relationship. Similar studies have reported high correlation between central and peripheral venous pressures, supporting the use of PVP as a viable alternative (1, 2).

The ability to use PVP as a surrogate for CVP has several clinical advantages. PVP measurement is less invasive compared to central venous catheterization, reducing the risk of complications such as infection, thrombosis, and catheter malposition (3, 5). In settings where central venous access is challenging or contraindicated, PVP provides a safer alternative while still offering valuable hemodynamic information. This is particularly relevant in surgical procedures like craniotomy, where precise monitoring of venous pressure is crucial for managing fluid balance and optimizing patient outcomes (8).

The findings of this study align with previous research suggesting that PVP can closely approximate CVP measurements. Studies have demonstrated that PVP can effectively track changes in CVP and provide similar insights into a patient's fluid status and cardiac function (7, 9). However, some research highlights that PVP might not capture certain aspects of central hemodynamics as accurately as CVP, particularly in patients with severe hemodynamic disturbances or altered venous tone (10).

Limitations: While the study offers promising results, it is not without limitations. The study was conducted at a single center with a relatively small sample size, which may affect the generalizability of the findings. Additionally, the study focused solely on patients undergoing craniotomy, and the applicability of these results to other surgical procedures or patient populations remains to be established. Further research with larger, multicenter trials is needed to validate these findings and explore the broader applicability of PVP as an alternative to CVP in various clinical scenarios (11, 12).

Future Directions: Future studies should investigate the effectiveness of PVP in different patient populations and surgical contexts to determine its reliability and accuracy compared to CVP in a broader range of clinical situations. Additionally, research into the potential limitations of PVP, such as its performance in patients with altered venous tone or in critical care settings, could provide further insights into optimizing venous pressure monitoring.

Conclusion:

This study demonstrates a strong positive correlation between central venous pressure (CVP) and peripheral venous pressure (PVP) in patients undergoing craniotomy. The high correlation coefficients across various time points suggest that PVP can serve as a reliable alternative to CVP for monitoring venous pressure in this surgical setting. Given the less invasive nature of PVP measurement, it offers a safer option for hemodynamic monitoring, reducing the risks associated with central venous catheterization.

These findings suggest that PVP could be integrated into clinical practice for managing patients undergoing craniotomy, particularly in cases where central venous access is difficult or contraindicated. However, further research is needed to validate these results in larger, diverse patient populations and across different types of surgeries. Future studies should also address any potential limitations of PVP monitoring in more complex clinical situations.

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