QANUN MEDIKA Vol 9 | No 2 July 2025
DOI: 10.30651/jqm.v9i02.26123

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JURNAL KEDOKTERAN FKUM SURABAYA
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Research Article

# Comparison between the ABC/2 technique and volumetric method using Philips access CT V2.0 software for subdural hematoma assessment at Siti Khodijah Muhammadiyah Sepanjang Hospital

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ARTICLE INFO

*Submitted* : *25th April 2025*
*Accepted* : *14th July 2025*
*Published* : *25th July 2025*

***Keywords:***
ABC/2 technique, CT-scan, subdural hematoma, volumetric

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## ABSTRACT

Subdural Hematoma (SDH) is a common pathological condition characterized by venous bleeding in the subdural space between the dura mater and the arachnoid membrane. Computed tomography (CT) scan plays a crucial role in diagnosing SDH and assessing the severity of the hemorrhage by estimating the hematoma volume. Various measurement techniques, including the ABC/2 formula and volumetric analysis, are used to determine SDH volume. This study aimed to compare the SDH volume results obtained from the ABC/2 technique and the volumetric technique using Philips Access CT V2.0 computer software. A cross-sectional study was conducted involving 30 patients diagnosed with SDH based on CT scan findings at Siti Khodijah Muhammadiyah Hospital, Sepanjang, Sidoarjo. Volume measurements were performed by a radiologist using the hospital's radiology computer. The ABC/2 technique involved manual measurement using linear dimensions, while the volumetric technique utilized Philips Access CT V2.0 computer software to obtain three-dimensional volume estimates. Data were analyzed using the Wilcoxon signed-rank test to determine statistical differences between the two techniques. The analysis showed no significant difference between the volumes measured by the ABC/2 and the volumetric techniques ($p = 0.382$; $p > 0.05$). In conclusion, the ABC/2 technique remains a practical and time-efficient method for estimating SDH volume, especially in clinical settings where rapid assessment is required.

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## INTRODUCTION

Subdural hematoma (SDH) is a pathological condition characterized by bleeding in the subdural space, located between the dura mater and the arachnoid membrane. This condition most commonly results from the rupture of bridging veins due to head trauma involving an acceleration-deceleration mechanism (Cheshire et al., 2018; Colasurdo et al., 2023; Pradana & Setyawati, 2022). The incidence of SDH is increasing in parallel with the growth of the elderly population, who are more susceptible to aneurysms and minor head injuries (McDonough et al., 2022). By 2030, SDH is projected to become the most prevalent cranial pathology among adults (Lakomkin et al., 2020). In Indonesia, data from the 2018 Basic Health Survey (Riskesdas) indicate a prevalence of traumatic brain injury is 11.9%, with the overall incidence of SDH estimated at approximately 20% (Kemenkes, 2022; Kemenkes RI, 2018). The clinical management of SDH heavily relies on the accurate assessment of hematoma volume on computed tomography (CT) scans, which plays a critical role in guiding therapeutic decisions (Won et al., 2018).

Despite the central role of CT imaging in SDH evaluation, the availability of CT scanners in Indonesia remains uneven. Java Island accounts for the majority of facilities (79%), while other regions, such as Sumatra (12%), Bali - Nusa Tenggara (4%), Kalimantan (3%), and Sulawesi (2%) are significantly underserved (BAPETEN, 2020). In addition to accessibility issues, technical parameters, particularly slice thickness, substantially influence the accuracy of hematoma volume measurements. Although most cranial CT examinations in Indonesia utilize slices 3-5 mm, recent evidence suggests that thinner slices produce more precise volume estimates. A study conducted at Haji General Hospital Surabaya demonstrated significant differences in SDH volume measurements between manual techniques using 5 mm slices and volumetric analysis using 1 mm slices (Mufida, 2022; Rizky et al., 2024; Setyo Kiswoyo et al., 2023). Nevertheless, comparative research on these measurement techniques within the Indonesian clinical context, particularly using thin-slice CT and updated volumetric software, remains scarce.

This study aims to assess the accuracy of SDH volume estimation by comparing the manual ABC/2 method and computer-assisted volumetric segmentation using CT scans with a slice thickness of 1.5 mm slice thickness. The ABC/2 method calculates hematoma volume based on linear dimensions (length (A), width (B), and depth (C)) using the formula (A x B x C)/2 (Gebel et al., 1998). In contrast, the volumetric technique employs advanced radiology software to automatically segment and calculate the three-dimensional volume of the hemorrhagic region (Kiswoyo et al., 2023). The use of thinner slices and modern software is expected to improve measurement accuracy and further validate the ABC/2 technique as a rapid and reliable diagnostic tool.

Although international studies have demonstrated strong correlations between both methods, they also acknowledge limitations related to slice thickness and software variability (Won et al., 2018; Gebel et al., 1998). Furthermore, these studies were predominantly conducted in high-resource settings with different population demographics and healthcare systems. Therefore, conducting a similar study in the local Indonesian context, specifically in the Sidoarjo region, is essential. The findings may offer empirical support for the practical application of the ABC.2 method in early SDH evaluation and contribute to the development of standardized CT-based radiological protocols in Indonesia.

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## METHODS

This study employed an observational analytical design with a cross-sectional approach. The study population consisted of 30 patients diagnosed with subdural hematoma (SDH) based on computed tomography (CT) imaging at Siti Khodijah Muhammadiyah Hospital, Sepanjang, Sidoarjo. Patients with intracranial lesions other than SDH, such as epidural haemorrhage, extensive intracerebral haemorrhage, and brain tumours, were excluded from the study. The research was conducted over a period spanning from December 2024 to February 2025. Data collection was performed using a Philips 16-slice CT scanner (model CT Access) with Philips Access CT V2.0 computer software. The CT imaging procedure began with the patient positioned supine on the CT scan table, which was then advanced into the gantry for image acquisition. The scanner emitted X-rays to obtain cross-sectional images of the cranial structures. The raw CT data were processed by a computer integrated with the CT system, generating detailed axial images suitable for further analysis. Diagnosis confirmation and volume measurements were conducted by a board-certified radiology specialist.

The volume of SDH was assessed using two measurement techniques: the ABC/2 method and a computer-based volumetric technique, which serves as the gold standard reference. The ABC/2 method estimated hematoma volume by calculating three primary parameters: length (A), width (B), and depth (C). Length (A) was defined as the maximum linear distance between the two ends of the subdural crescent on axial images. Width (B) was determined by measuring the maximum perpendicular distance to the length, representing the greatest hematoma thickness. Depth (C) was calculated by multiplying the number of CT slices showing the hematoma by the slice thickness. The final estimated hematoma volume was calculated using the formula proposed by Gebel et al. (1998):

$$\textbf{Volumetric} = \frac{AxBxC}{2}$$

**Explanation:**
A: length
B : width
C : depth

In addition, SDH volume was measured using the Philips Access CT V2.0 computer software-based volumetric technique incorporating three-dimensional image segmentation. This process involved activating the 3D analysis feature within the Philips Access CT V2.0 computer software, allowing visualization of axial, sagittal, and coronal planes for more accurate hematoma delineation. The superior-inferior and medial-lateral boundaries of the hematoma were manually outlined to facilitate precise volume calculation (Setyo Kiswoyo et al., 2023). The volumetric technique was considered the gold standard for SDH volume measurement (Won et al., 2018).

For statistical analysis, data normality was assessed using the Shapiro-Wilk test. Descriptive statistics were presented as frequency distributions for categorical variables. The Wilcoxon signed-rank test was used to compare differences in SDH volume measurements between the ABC/2 and volumetric methods. Statistical analysis was performed using SPSS software version 25, with a significance level set at $p < 0.05$. This study obtained ethical approval from the Health Research Ethics Committee of Siti Khodijah Muhammadiyah Hospital, Sepanjang, under approval number 29/KET-KEPK/10-2024.

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## RESULTS

Based on the data presented in Table 1, the majority of respondents in this study were male, comprising 66.7% of the total sample. Furthermore, the age distribution demonstrated that individuals aged over 60 years represented the largest proportion of the study population, accounting for 56.7% of participants. These findings suggest that subdural hematoma (SDH) in this study was more prevalent among males and older adults, which is consistent with previous epidemiological studies highlighting age and gender as significant risk factors for SDH occurrence.

As illustrated in Figure 1, the ABC/2 technique for measuring subdural hematoma (SDH) volume consistently yielded larger volume estimates compared to the volumetric method, particularly in cases where the hematoma volume exceeded 30 cc. The discrepancy between the two measurement techniques became more pronounced with increasing hematoma size. These findings indicate a potential tendency for the ABC/2 method to overestimate hematoma volume, especially in patients with larger SDH.

**Table 1.** Characteristics of Samples (n=30)

| Characteristics | Frequency (Percentage) |
|---|---|
| **Gender** | |
| Male | 20 (66.7%) |
| Females | 10 (33.3%) |
| **Age** | |
| 10-19 | 1 (3.3%) |
| 20-44 | 7 (23.3%) |
| 45-59 | 5 (16.7%) |
| >60 | 17 (56.7%) |

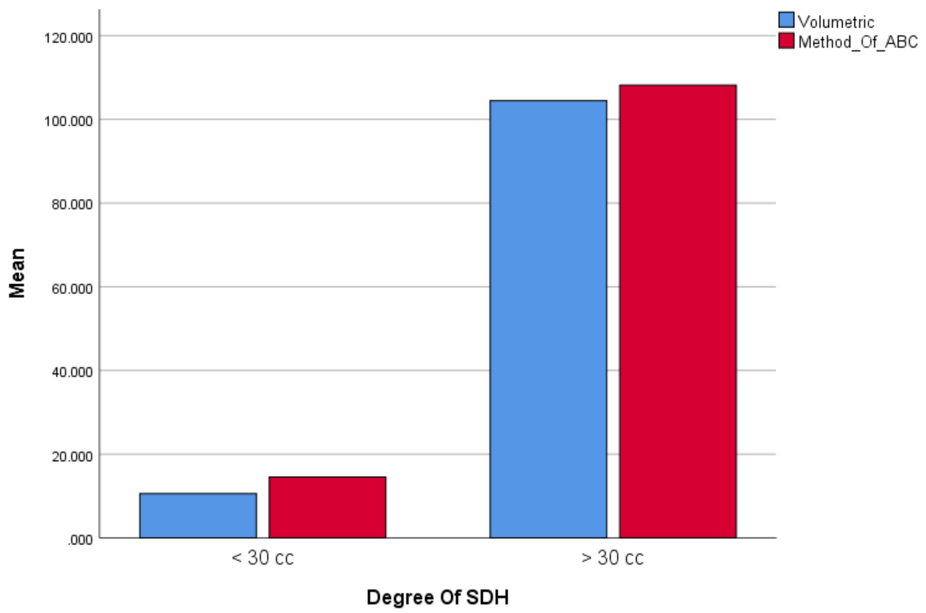


**Figure 1.** Degree of SDH

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The descriptive statistical analysis presented in Table 2 demonstrates that the ABC/2 method yields a higher mean subdural hematoma (SDH) volume compared to the volumetric method. Additionally, the ABC/2 technique shows a wider range of measurement values, reflecting greater variability in the estimated volumes. This observation is consistent with previous findings indicating that the ABC/2 method tends to overestimate hematoma volume relative to the volumetric gold standard. The greater data dispersion observed with the ABC/2 technique further highlights its lower measurement precision. These findings suggest a potential overestimation bias associated with the ABC/2 method when applied for SDH volume assessment.

Based on the results presented in Table 3 and Table 4, statistical analysis using the Wilcoxon Signed Rank test yielded an Asymp. Significance (2-tailed) value of $p = 0.382$ ($p > 0.05$). This p-value indicates that there was no statistically significant difference in the measured subdural hematoma (SDH) volumes between the ABC/2 technique and the volumetric analysis method. These findings suggest that, within the study sample, both measurement techniques produced comparable volume estimates during head CT scan examinations conducted at Siti Khodijah Muhammadiyah Hospital, Sepanjang.

**Table 3.** Wilcoxon Hypothesis Test

| Test Statistics[a] | |
|---|---|
| | **Method of ABC/2 - Volumetric** |
| **Z** | -.874[b] |
| **Asymp. Sig. (2-tailed)** | 0.382 |

a = Wilcoxon Signed Rank Test
b = Based on negative ranks

**Table 4.** Output of the Wilcoxon Test

| Ranks | | | | |
|---|---|---|---|---|
| | | **N** | **Mean Rank** | **Sum of Ranks** |
| **Method of ABC/2 - Volumetrik** | Negative Ranks | 12[a] | 15.83 | 190.00 |
| | Positive Ranks | 18[b] | 15.28 | 275.00 |
| | Ties | 0[c] | | |
| | Total | 30 | | |

a = Method of ABC/2 < Volumetric
b = Method of ABC/2 > Volumetric
c = Method of ABC/2 = Volumetric

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**Table 5.** Correlation Test

| Correlations | | | | |
|---|---|---|---|---|
| | | | Volumetric | ABC Technique |
| Spearman's rho | Volumetric | Correlation Coefficient | 1.000 | .966** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 30 | 30 |
| | Method of ABC/2 | Correlation Coefficient | .966** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 30 | 30 |

** Correlation is significant at the 0.01 level (2-tailed)

Based on the data presented in Table 5, Spearman's correlation analysis demonstrated a significance value (2-tailed) of 0.000 ($p < 0.05$), indicating a statistically significant correlation between the ABC/2 method and the volumetric technique. The correlation strength was categorized as very strong, as reflected by a correlation coefficient (r) of 0.966, which is close to the maximum value of 1 within the accepted correlation range ($-1 \leq r \leq +1$). Additionally, the positive direction of the correlation indicates that an increase in SDH volume measurements using the ABC/2 technique is associated with an increase in volumes measured by the volumetric method.

## DISCUSSION

An analysis of subdural hematoma (SDH) patient characteristics at Siti Khodijah Muhammadiyah Hospital Sepanjang revealed that the majority of patients were male, comprising 66.7% of the total sample, with a male-to-female ratio of approximately 2:1. This finding aligns with the study by J. Oh et al., 2014, which reported a higher incidence of SDH among males with a ratio of 5.2:1. Several factors may contribute to this gender disparity, including anatomical differences, where males typically have larger cranial dimensions, increasing the risk of bridging vein stretching within the subdural space during head trauma (Cheshire et al., 2018; Oh et al., 2014). In addition to anatomical factors, lifestyle-related physical activities also appear to influence the higher SDH incidence in males. Siahaya *et al.* (2020) reported that men tend to engage in more outdoor and high-risk physical activities, which increases their likelihood of experiencing head trauma.

In terms of age distribution, the majority of SDH patients were over 60 years old, accounting for 56.7% of the study population. This result is consistent with the findings of Marshman, Manickam, and Carter (2015), who highlighted that the incidence of SDH increases with advancing age due to cerebral atrophy. The study by Marshman et al. (2015) reported mean ages of 72 ± 13 years for female patients and 68 ± 15 years for male patients (Marshman, Manickam, and Carter, 2015). Age-related reductions in brain volume contribute to the stretching of intracranial blood vessels, thereby increasing the risk of bleeding following minor trauma, particularly among elderly patients who are often prescribed anticoagulant and antiplatelet therapies (Marshman et al., 2015; Mishra et al., 2022; Shin & Hwang, 2020).

Regarding the measurement of SDH volume, the results of this study indicate that the ABC/2 technique tends to produce larger volume

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estimates compared to the volumetric method, especially for hematomas exceeding 30 cc. Leary et al. (2021) also observed that SDH volumes above 50 cc measured using the ABC/2 method were significantly overestimated compared to volumetric calculations ($p < 0.0001$). However, for smaller hematomas (<50 cc), the difference between the two techniques was not statistically significant. This overestimation tendency is more pronounced in hematomas with irregular shapes, which deviate from the ellipsoid assumption inherent to the ABC/2 formula (Leary et al., 2021). The Shapiro-Wilk normality test in this study showed that data from both measurement methods were not normally distributed ($p < 0.05$), leading to the use of the Wilcoxon signed-rank test for hypothesis testing. The test yielded a p-value of 0.382, indicating no significant difference between SDH volume measurements obtained using the ABC/2 technique and the volumetric method. The mean SDH volume calculated with ABC/2 was 83.2 cc, compared to 79.41 cc by volumetric analysis. Furthermore, Spearman's correlation analysis revealed a very strong positive correlation ($r = 0.966$; $p < 0.05$). These findings are consistent with previous studies by Gebel et al. (1998) and Won et al. (2018), who reported Pearson correlation coefficients of $r = 0.842$ and $r = 0.934$, respectively. Additionally, Bland-Altman analysis by Won et al. (2018) demonstrated no significant systematic bias between the two measurement methods.

The ABC/2 technique offers several practical advantages in SDH volume measurement, particularly in hospitals with limited resources. Its simplicity allows bedside application, with calculations that do not require specialized software or radiology workstations. Length (A), width (B), and depth (C) can be manually measured from axial CT images, making this method both fast and time-efficient as it avoids the need for image segmentation or computer-based volumetric analysis. Volume estimation can be completed within minutes using only a simple calculator (Cuce et al., 2020). Based on these findings, it can be concluded that the ABC/2 technique remains a viable option for SDH volume measurement, providing faster estimation times without dependence on advanced volumetric tools (Won et al., 2018). However, this study has several limitations. As a retrospective observational study utilizing secondary data from hospital medical records, the researchers had limited control over data quality and completeness. Additionally, the relatively small sample size, driven by the low incidence of SDH, and potential subjectivity in determining hematoma dimensions using the ABC/2 method, may have affected the accuracy of the results.

## CONCLUSION

The findings of this study indicate that the ABC/2 technique remains a practical, reliable, and accessible method for estimating subdural hematoma (SDH) volume, particularly in healthcare settings with limited resources. Although the ABC/2 method demonstrated a tendency to slightly overestimate hematoma volumes, especially in cases with larger or irregularly shaped lesions, it exhibited a very strong positive correlation with the volumetric gold standard, as reflected by a Spearman correlation coefficient of $r = 0.966$. The absence of statistically significant differences between the two measurement techniques further reinforces the clinical utility of the ABC/2 method as a valid alternative for SDH volume assessment. Its simplicity, rapid execution time, and independence from specialized imaging software make it especially suitable for use in emergencies where prompt clinical decision-making is critical.

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