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Handedness, Lesion Laterality and Surgical Outcomes in Intracranial Neurosurgical Patients in Ado-Ekiti, Nigeria

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Abstract

Background: Handedness reflects cerebral lateralization and may serve as a practical indicator of hemispheric dominance, particularly in resource-limited neurosurgical settings. However, its clinical relevance among neurosurgical patients in sub-Saharan Africa remains underexplored.

Objective: To determine the distribution of handedness and evaluate its relationship with lesion laterality and surgical outcomes among intracranial neurosurgical patients in Ado-Ekiti, Nigeria.

Methods: This retrospective descriptive and analytical study included patients managed for intracranial neurosurgical conditions between January 2021 and December 2025. Data on demographics, handedness, diagnosis, lesion laterality, surgical intervention, and outcomes were extracted from clinical records. Statistical analysis was performed using SPSS version 25.0, with associations assessed using appropriate inferential statistical test such as the chi-square test.

Results: Among 329 patients, 85.1% were right-handed, 11.2% left-handed, and 3.7% mixed-handed. Left hemispheric lesions were most frequent (46.5%). Although right-handed patients more commonly had left-sided lesions, the association between handedness and lesion laterality was not significant ($\chi^2 = 3.98$, $p = 0.68$). Of 222 surgical patients, 65.3% improved, and mortality was 5.0%. Postoperative outcomes did not differ significantly across handedness groups ($\chi^2 = 5.21$, $p = 0.52$).
Conclusion: Handedness distribution mirrors global patterns. While it reflects general cerebral lateralization, it does not significantly influence short-term surgical outcomes.

Keywords: Cerebral lateralization, Handedness, Intracranial neurosurgery, Lesion laterality, Surgical outcomes

I. Introduction

Handedness, defined as the preferential use of one hand for skilled motor tasks, is a fundamental expression of cerebral lateralization and reflects the functional asymmetry of the human brain [1]. In most individuals, motor dominance is linked to hemispheric specialization, with the left cerebral hemisphere typically controlling language and fine motor functions, corresponding to right-hand preference [2, 3]. Globally, approximately 85-90% of individuals are right-handed, while left-handedness accounts for about 10-12%, with a small proportion exhibiting mixed or ambidextrous patterns [4, 5].

The biological basis of handedness is complex and multifactorial, involving both genetic and environmental influences [5, 6]. Large-scale analyses have demonstrated that while the overall distribution of handedness is relatively stable across populations, its expression may be influenced by sociocultural factors [4, 7]. In many developing regions, including parts of Africa, sociocultural norms have historically discouraged the use of the left hand, particularly in early childhood, potentially influencing the expression of natural hand preference [8, 9].

In Nigeria and other sub-Saharan African settings, studies have reported prevalence rates of left-handedness generally ranging between 5% and 12%, depending on methodology and population characteristics [10, 11]. Urban populations tend to demonstrate higher reported rates, likely reflecting greater sociocultural acceptance [12]. These findings underscore the importance of context-specific data when evaluating handedness in African populations.

Beyond its epidemiological significance, handedness has important clinical implications in neurosurgical practice. It is commonly used as a surrogate marker for cerebral dominance, particularly in settings where advanced functional imaging techniques such as functional magnetic resonance imaging or intraoperative cortical mapping are not readily available [13, 14]. Knowledge of handedness may therefore guide surgical planning, risk stratification, and prediction of postoperative functional deficits, especially in procedures involving eloquent cortical regions [14, 15].

Despite its relevance, there remains limited data on handedness in neurosurgical contexts, with most existing studies focusing on surgeons or general populations rather than patient cohorts [16]. Furthermore, there is a lack of published data from Nigerian neurosurgical centers, including Ekiti State University Teaching Hospital, Ado-Ekiti. This study therefore aimed to evaluate the distribution of handedness and its association with lesion laterality and postoperative outcomes among intracranial neurosurgical patients in Ado-Ekiti, Nigeria.

II. Methodology

2.1. Study Design and Setting

This study employed a retrospective descriptive and analytical design and was conducted at Ekiti State University Teaching Hospital (EKSUTH), Ado-Ekiti. EKSUTH is a tertiary healthcare institution that serves as a major referral center for neurosurgical care in Ekiti State and neighboring regions in Southwestern Nigeria. The study was conducted over a period of 4 months from January 2026 to April 2026.

2.2. Study Population

The study population comprised all patients managed for neurosurgical conditions at EKSUTH over a 5-year period, from January 2021 to December 2025. Both patients who underwent surgical intervention and those managed conservatively were included in the analysis.

2.3. Eligibility Criteria

Patients were eligible for inclusion if they had a confirmed diagnosis of a neurosurgical condition-such as traumatic, neoplastic, degenerative, congenital, vascular, or infectious pathologies-and had complete or adequately documented clinical records.

Patients were excluded if their records were incomplete, particularly where key variables such as handedness were missing, or where clinical documentation was insufficient or ambiguous for reliable data extraction.

2.4. Data Collection

Data were obtained from patient case notes, admission registers, and operative records using a structured data collection proforma designed for the study. Information collected included sociodemographic characteristics, handedness, clinical diagnosis, and diagnostic category.

Radiological details, including lesion laterality and anatomical location, were also documented, alongside information on surgical interventions and clinical outcomes at discharge. Handedness classification was based on documented or self-reported preference and categorized into right-handed, left-handed, or mixed-handed groups.

2.5. Data Analysis

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were used to summarize the study variables, with categorical data presented as frequencies and percentages.

Analytical evaluation was performed to explore relationships between handedness and key clinical variables, including lesion laterality and clinical outcomes. These associations were examined using cross-tabulations. Where appropriate, inferential statistical tests such as the chi-square test were applied to assess the significance of observed associations, with a p-value of less than 0.05 considered statistically significant.

2.6. Ethical Consideration

Ethical approval was obtained from the institutional research and ethics committee of EKSUTH. Patient confidentiality was maintained throughout the study, and no identifying information was recorded.

III. Results

A total of 329 patients with intracranial neurosurgical conditions were included in this study.

3.1. Socio-demographic Characteristics

The study population demonstrated a clear male predominance, with males accounting for 203 patients (61.7%), while females constituted 126 patients (38.3%) with a male to female ratio of 1.6: 1 (Table 1).

Age distribution showed that the largest proportion of patients fell within the 40-59 year age group, representing 105 patients (31.9%). This was closely followed by those aged 19-39 years, who accounted for 101 patients (30.7%). Patients aged 60 years and above comprised 70 individuals (21.3%), while the youngest age group (0-18 years) represented 53 patients (16.1%). Overall, the findings indicate that middle-aged adults, particularly those in the fifth and sixth decades of life, formed the bulk of the study population.

3.2. Distribution of Handedness

Right-handedness was overwhelmingly predominant among the study population, observed in 280 patients (85.1%). Left-handed individuals accounted for 37 patients (11.2%), while mixed or ambidextrous handedness was relatively uncommon, seen in only 12 patients (3.7%) (Table 2).

This distribution reflects a clear dominance of right-handedness, with left-handed and mixed-handed individuals forming a relatively small proportion of the cohort.

3.3. Clinical Spectrum of Neurosurgical Conditions

Traumatic brain injury emerged as the most common clinical presentation, affecting 142 patients (43.2%) (Table 3). Tumors were the second most frequent diagnosis, accounting for 96 patients (29.2%).

Vascular conditions were identified in 41 patients (12.5%), while congenital anomalies and infections accounted for 27 patients (8.2%) and 23 patients (6.9%), respectively.

Overall, the clinical spectrum was dominated by trauma and neoplastic conditions, which together constituted the majority of cases managed during the study period.

3.4. Handedness and Lesion Laterality

Analysis of lesion laterality showed that left hemispheric lesions were the most common, occurring in 153 patients (46.5%), followed by right hemispheric lesions in 121 patients (36.8%) (Table 4). Bilateral and midline lesions were less frequent, accounting for 31 patients (9.4%) and 24 patients (7.3%), respectively.

Among right-handed patients, nearly half (47.5%) had lesions located in the left hemisphere, compared to 36.8% in the right hemisphere. In contrast, left-handed and mixed-handed individuals demonstrated a more evenly distributed pattern of lesion laterality, without a clear hemispheric predominance.

Despite these observable trends, statistical analysis showed no significant association between handedness and lesion laterality ($\chi^2 = 3.98$, $df = 6$, $p = 0.68$), indicating that the distribution of lesions across hemispheres did not differ meaningfully according to handedness.

3.5. Surgical Intervention and Outcomes

Out of the total study population, 222 patients (67.5%) underwent surgical intervention, while 107 patients (32.5%) were managed non-operatively (Table 5).

Among patients who underwent surgery, the majority experienced clinical improvement at discharge, accounting for 145 patients (65.3%). A further 42 patients (18.9%) showed no significant change in clinical status. Deterioration was observed in 24 patients (10.8%), while 11 patients (5.0%) died.

These findings indicate that surgical intervention was associated with favorable short-term outcomes in a substantial proportion of patients, with nearly two-thirds demonstrating improvement.

3.6. Association between Handedness and Postoperative Outcomes

Postoperative outcomes were broadly similar across all handedness groups (Table 6). Clinical improvement was observed in 66.3% of right-handed patients, 60.9% of left-handed patients, and 55.6% of mixed-handed patients.

The proportion of patients whose condition remained unchanged was comparable across groups, occurring in 19.0% of right-handed, 17.4% of left-handed, and 22.2% of mixed-handed individuals. Similarly, worsening of clinical status was observed in 10.5% of right-handed patients, 13.0% of left-handed patients, and 11.1% of mixed-handed patients.

Mortality rates were slightly higher among left-handed (8.7%) and mixed-handed patients (11.1%) compared to right-handed patients (4.2%), although the absolute numbers were small.

Overall, statistical analysis demonstrated no significant association between handedness and postoperative outcomes ($\chi^2 = 5.21$, df = 6, p = 0.52), indicating that handedness did not have a meaningful influence on short-term surgical outcomes in this cohort.

Tables of Results

Table 1 Socio-demographic Characteristics of the Study Population (N = 329)

Variable	Category	Frequency (n)	Percentage (%)
Age group	0-18	53	16.1
	19-39	101	30.7
	40-59	105	31.9
	≥60	70	21.3
Sex	Male	203	61.7
	Female	126	38.3

Table 2 Distribution of Handedness among the Study Population (N = 329)

Handedness	Frequency (n)	Percentage (%)
Right-handed	280	85.1
Left-handed	37	11.2
Mixed/Ambidextrous	12	3.7

Table 3 Clinical Spectrum of Neurological Diagnoses (N = 329)

Diagnosis category	Frequency (n)	Percentage (%)
Trauma (TBI)	142	43.2
Tumors	96	29.2
Vascular	41	12.5
Congenital anomalies	27	8.2
Infections (abscess)	23	6.9

Table 4 Association between Handedness and Lesion Laterality (N = 329)

Lesion laterality	Right-handed n (%)	Left-handed n (%)	Mixed n (%)	Total (%)
Left hemisphere	133 (47.5)	16 (43.3)	4 (33.3)	153 (46.5)
Right hemisphere	103 (36.8)	14 (37.8)	4 (33.3)	121 (36.8)
Bilateral	25 (8.9)	4 (10.8)	2 (16.7)	31 (9.4)
Midline	19 (6.8)	3 (8.1)	2 (16.7)	24 (7.3)
Total (n)	**280**	**37**	**12**	**329**

Statistical test Chi Square $\chi^2 = 3.98$, df = 6, $p = 0.68$
Values are expressed as frequency (percentage). Percentages are calculated within each handedness category (column percentages). Total percentages are based on the overall study population.

Table 5 Surgical Intervention Status and Postoperative Outcomes (N = 329)

Variable	Category	Frequency (n)	Percentage (%)
Surgery performed	Yes	222	67.5

	No	107	32.5
Postoperative outcome (n = 222)	Improved	145	65.3
	Same	42	18.9
	Worse	24	10.8
	Death	11	5.0

Postoperative outcomes are based on patients who underwent surgical intervention (n = 222). Percentages are calculated within each category.

Table 6 Association between Handedness and Postoperative Outcomes (N = 222)

Outcome	**Right-handed n (%)**	**Left-handed n (%)**	**Mixed n (%)**	**Total (%)**
Improved	126 (66.3)	14 (60.9)	5 (55.6)	145 (65.3)
Same	36 (19.0)	4 (17.4)	2 (22.2)	42 (18.9)
Worse	20 (10.5)	3 (13.0)	1 (11.1)	24 (10.8)
Dead	8 (4.2)	2 (8.7)	1 (11.1)	11 (5.0)
Total (n)	**190**	**23**	**9**	**222**

Statistical test Chi Square $\chi^2 = 5.21$, df = 6, $p = 0.52$
Values are expressed as frequency (percentage). Percentages are calculated within each handedness category (column percentages). Analysis is based on patients who underwent surgery (n = 222).

IV. Discussion

4.1. Overview of Key Findings

This study evaluated the distribution of handedness and its clinical relevance among patients with intracranial neurosurgical conditions in a resource-limited setting. The findings demonstrate a predominance of right-handedness, a higher frequency of left hemispheric lesions, and no statistically significant association between handedness and either lesion laterality or postoperative outcomes. These observations are consistent with established principles of brain asymmetry and clinical variability in neurological populations [1-3].

4.2. Socio-demographic Profile and Disease Pattern

The observed male predominance and peak age distribution in the fourth to sixth decades are consistent with patterns reported in neurosurgical practice across low- and middle-income countries, where trauma and tumors constitute major contributors to disease burden [17]. Traumatic brain injury was the leading diagnosis in this study, reflecting its continued predominance in developing regions. The substantial proportion of tumors and vascular lesions further highlights the growing impact of non-communicable neurological disorders.

4.3. Distribution of Handedness

The predominance of right-handedness (85.1%) observed in this study aligns with global estimates of approximately 85-90% reported in large population-based analyses [4, 5] Similar distributions have been documented in Nigerian populations, although reported prevalence may vary depending on age group and sociocultural influences [10, 11].

Handedness is widely regarded as a multifactorial trait influenced by genetic and developmental factors rather than being purely genetically determined [5, 6]. While sociocultural pressures-particularly in some African settings-may influence the expression of left-handedness, they do not substantially alter the overall population distribution [7, 9].

4.4. Handedness and Cerebral Lateralization

The predominance of left hemispheric lesions observed in this study, particularly among right-handed individuals, is consistent with well-established evidence that the left hemisphere is dominant for language and

fine motor functions in the majority of right-handed individuals [2, 13]. Functional imaging studies have demonstrated this relationship consistently in neurologically normal populations [13].

However, inter-individual variability in hemispheric organization is well recognized [18]. Left-handed individuals, in particular, are more likely to exhibit atypical patterns of cerebral dominance, including right hemispheric or bilateral representation of language functions [14, 19]. This variability likely explains the more heterogeneous lesion distribution observed among left-handed and mixed-handed patients in this study.

Despite these observable trends, the lack of a statistically significant association between handedness and lesion laterality suggests that handedness alone is an imprecise predictor of cerebral dominance at the individual level. This finding is consistent with previous studies emphasizing that handedness, while correlated with hemispheric specialization, does not reliably determine functional localization in clinical settings [13, 14].

4.5. Handedness and Surgical Outcomes

This study found no significant association between handedness and postoperative outcomes. Although minor variations in outcome distribution were observed across handedness groups, these differences were small and lacked a consistent pattern. The majority of patients in all groups experienced clinical improvement, indicating that handedness does not meaningfully influence short-term surgical outcomes.

These findings are consistent with existing literature suggesting that handedness does not independently influence surgical outcomes as previous neuroimaging and clinical studies have shown that handedness is an inconsistent predictor of hemispheric dominance and functional recovery [2, 14, 20].
Furthermore, studies examining handedness among surgeons have demonstrated that left-handed individuals can adapt effectively within predominantly right-handed surgical environments, often developing ambidextrous skills without compromising performance [21, 22].

Overall, these observations reinforce the concept that handedness is not a primary determinant of clinical outcome in neurosurgical practice.

4.6. Clinical Implications in Resource-Limited Settings

In resource-limited settings where advanced functional imaging techniques such as functional MRI or intraoperative cortical mapping are not readily available, handedness remains a practical and accessible clinical tool for approximating cerebral dominance [13, 14].

However, the findings of this study highlight the limitations of relying solely on handedness. Given its variability and limited predictive accuracy, it should be interpreted in conjunction with clinical and radiological findings rather than used as a standalone determinant in surgical planning.

4.7. Strengths and Limitations

A key strength of this study is its focused evaluation of intracranial neurosurgical conditions, which enhances its relevance to cerebral lateralization. It also contributes to the limited body of literature on handedness in neurosurgical populations in sub-Saharan Africa.

However, the retrospective design introduces inherent limitations, including reliance on documented or self-reported handedness, which may be subject to misclassification bias. The absence of standardized assessment tools limits precision, and the lack of functional imaging data precludes direct evaluation of hemispheric dominance, which may vary independently of handedness [13, 14].

V. Conclusion

The distribution of handedness among patients with intracranial neurosurgical conditions in this study is consistent with global and regional patterns, with right-handedness predominating. While handedness shows a

general relationship with cerebral lateralization, it does not significantly influence postoperative outcomes. Handedness remains a useful but limited clinical indicator and should be interpreted within the broader context of comprehensive neurosurgical assessment.

VI. Compliance with ethical standards

Author contributions

All authors contributed to the conception and design of the study, interpretation of data, drafting of the manuscript, and approval of the final version.

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Ethical approval statement

Ethical approval was obtained from the Hospital Research and Ethics Committee prior to commencement of the study. The study was carried out in accordance with the ethical standards of the institutional research committee and the principles of the Declaration of Helsinki.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this article.

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Data Availability Statement

The datasets generated and analyzed during the study are available from the corresponding author upon reasonable request.

United Nations Declaration of Human Rights

The authors confirm that they accept and agree with the UN's Declaration of Human Rights.

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