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# IMPACT OF POST OPERATIVE NEUROCOGNITIVE EXERCISES IN CRANIOTOMY PATIENTS

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**ABSTRACT**

**Background:** Early rehabilitation is essential following craniotomy to restore cognitive and motor functions. This study evaluated the effect of a structured rehabilitation program incorporating postoperative neurocognitive exercises on patients' knowledge, practice, balance, and cognitive outcomes.
**Materials and Methods:** A quasi-experimental study was conducted at a tertiary care hospital in Tamil Nadu from September 2024 to September 2025. Eighty oriented post-craniotomy patients were purposively selected and assigned equally to a study group, which received the structured rehabilitation program including neurocognitive exercises (orientation, recall, sequencing, and visual–spatial tasks), and a control group that received routine care. Cognitive and balance functions were assessed using the Mini-Mental State Examination (MMSE) and Berg Balance Scale (BBS), while knowledge and practice were measured through structured questionnaires before and after intervention. Statistical analyses included Chi-square, paired and independent t-tests, and Pearson's correlation; $p < 0.05$ was considered significant.
**Results:** The study group demonstrated significant post-intervention improvement in knowledge (87.5% vs. 20%; $p < 0.001$), practice (82.5% vs. 22.5%; $p < 0.001$), cognitive scores (MMSE $27.6 \pm 2.1$ vs. $22.8 \pm 2.9$; $p < 0.01$), and balance (BBS $52.4 \pm 2.8$ vs. $44.7 \pm 3.0$; $p < 0.01$). The mean hospital stay was shorter in the study group ($9.8 \pm 5.4$ days; $p < 0.05$). Significant correlations were found between education and knowledge ($r = 0.69$) and between knowledge and practice ($r = 0.48$).
**Conclusion:** Structured rehabilitation, including postoperative neurocognitive exercises, effectively enhances recovery in craniotomy patients by improving cognition, balance, and self-care practices. Integration of such programs into routine postoperative care is strongly recommended.
**Keywords:** Craniotomy, Neurocognitive rehabilitation, Balance, Cognitive function, Nursing intervention.

## INTRODUCTION

Despite significant advances in diagnosis and treatment, primary brain tumors continue to be associated with substantial morbidity and mortality. The current standard of care for newly diagnosed brain tumor patients involves maximal safe tumor excision, followed by adjuvant chemotherapy or radiotherapy.[1] Among surgical procedures for brain tumor management, craniotomy remains the most frequently performed operation. This technique involves the temporary removal of a bone flap from the skull to access the brain.

Following a craniotomy, comprehensive and regular nursing assessments are essential to monitor for potential neurological impairments such as effusion, hematoma, seizure, hydrocephalus, or sustained hypertension.[2] Due to the infiltrative nature of brain tumors and the complexity of surgical management, achieving an optimal balance between maximal tumor resection and preservation of neurological function can be challenging. The short postoperative course is often complicated by adverse events, including extended hospitalization, reoperation, and readmission.[3] Moreover, postoperative neurological deficits may have unclear etiologies, making it difficult to predict the extent and pace of recovery. Hence, comprehensive preoperative evaluation plays a crucial role in anticipating postoperative outcomes.[4]

Post-craniotomy patients frequently experience cognitive and physical dysfunctions. These include decreased attention, slowed information processing, memory deficits, reduced concentration, and fatigue. Many patients also report dizziness and balance impairments, which limit their ability to perform activities of daily living (ADL) and engage in social interactions. Determining the extent of cognitive and physical impairment is vital for designing an individualized and effective rehabilitation program.[5,6]

Cognitive and physical rehabilitation interventions have been shown to effectively address these deficits. Neurosurgical nurses play a proactive and integral role in facilitating postoperative rehabilitation through evidence-based interventions and close patient monitoring. Rehabilitation and structured nursing management have been demonstrated to reduce disability rates and enhance mental well-being and quality of life among postoperative patients.[7] The primary aim of rehabilitation following intracranial tumor surgery is to restore patient independence, emphasizing mobility, daily functioning, cognition, and communication. The specific goals of prehabilitation and rehabilitation depend on the patient's postoperative challenges. Importantly, early initiation of rehabilitation is associated with better functional outcomes and reduced complication rates.[8]

Evidence from the literature indicates that patients who undergo craniotomy for brain tumor excision frequently experience deficits in balance and attention. These impairments can significantly restrict the ability to perform activities of daily living and limit participation in social and occupational activities. Despite the growing burden of brain tumors, limited research has focused on the impact of postoperative rehabilitation on balance and cognitive recovery following craniotomy. This gap underscores the need for structured neurorehabilitation protocols aimed at improving cognitive and motor outcomes in this patient population.

Postoperative neurocognitive exercises form a vital component of such rehabilitation, targeting domains of memory, attention, executive function, and problem-solving. These exercises typically include orientation activities, recall and recognition tasks, sequencing and categorization exercises, visual–spatial training, and problem-solving games. When implemented under guided supervision, they enhance neuroplasticity, promote reorganization of cognitive pathways, and facilitate faster recovery of higher mental functions. Regular engagement in neurocognitive exercises not only improves short-term cognitive outcomes but also contributes to better adaptation and self-care during the recovery phase.

The present study, therefore, aims to evaluate the effectiveness of a structured postoperative rehabilitation program—integrating physical, cognitive, and neurocognitive exercises—in enhancing cognitive and balance functions among patients who have undergone craniotomy for brain tumor removal. Cognitive function refers to a broad set of mental processes involved in acquiring, processing, and utilizing information, encompassing multiple domains including perception, memory, learning, attention, decision-making, and language.[9] Rehabilitation is defined as a process involving a series of interventions designed to optimize functional capacity and reduce disability in individuals with health conditions, enabling them to interact effectively within their environment.[10]

The study sought to assess patients' knowledge and practices related to craniotomy, as well as to evaluate their balance and cognitive functions both before and after surgery. Based on these assessments, a rehabilitation program was designed and implemented according to the identified needs of the patients. Furthermore, the study aimed to evaluate the effectiveness of the rehabilitation program in improving patients' knowledge, practices, balance, cognitive outcomes, and postoperative neurocognitive functions following craniotomy. In addition, the study explored the relationship between patients' knowledge and practice regarding craniotomy and their demographic characteristics, as well as the correlation between knowledge and practice levels among post-craniotomy patients.

## MATERIALS AND METHODS

**Study Design and Setting:** This study employed a quasi-experimental design and was conducted at a tertiary care hospital in Tamil Nadu, India. The study aimed to determine the effect of a structured rehabilitation program on patients' practice, balance, cognitive functions, and post-operative neurocognitive performance following craniotomy.

**Study Period:** The study was conducted over twelve months, from September 2024 to September 2025.

**Sample Size and Sampling Technique:** A purposive sample of 80 oriented post-craniotomy patients was selected and divided equally into two groups:

- **Study group (n = 40):** Received the structured rehabilitation program, including post-operative neurocognitive exercises.
- **Control group (n = 40):** Received routine postoperative care.

The neurocognitive exercises component focused on restoring cognitive functions affected by surgery. These included orientation training, simple calculation tasks, word recall, sequencing and problem-solving activities, and visual–spatial coordination tasks. Exercises were administered under the supervision of a neuro-rehabilitation nurse and physiotherapist, with individualized progression based on each patient's performance and tolerance.

Cognitive and motor functions were assessed at four time points—preoperatively, postoperatively, prior to hospital discharge, and one to two months after surgery. Additionally, patients' knowledge and practice levels related to craniotomy were evaluated both before and after the implementation of the rehabilitation program.

**Inclusion Criteria**

- Age: 18–65 years
- Diagnosis: Newly admitted patients planned for craniotomy
- Rehabilitation history: No prior participation in a structured rehabilitation program
- Level of consciousness: Conscious and oriented (Glasgow Coma Scale [GCS] 14–15)
- Willingness to participate and provide informed consent

**Exclusion Criteria**

- History of neurological disorders such as memory impairment, dementia, epilepsy, or aphasia
- Altered consciousness at the time of assessment
- Cognitive inability to follow rehabilitation instructions
- Previous brain surgery prior to the current craniotomy

**Ethical Considerations:** Ethical approval was obtained from the Institutional Ethics Committee prior to study commencement. Written informed consent was secured from all participants after explaining the study objectives and procedures in the local language (Tamil). Confidentiality and anonymity were maintained throughout data collection and analysis.

**Data Collection Tool and Procedure**

Tool I: Patient Assessment Sheet Post-Craniotomy

This tool consisted of two parts:

- Part I: Demographic data (age, education, residence, occupation).
- Part II: Medical history (type of brain tumor, diagnostic findings, duration of hospitalization, and level of consciousness).

The Glasgow Coma Scale (GCS) developed by Teasdale and Jennett (1974) was used to assess consciousness levels.

Tool II: Patients' Knowledge Regarding Craniotomy (Pre- and Post-Test Format)

Developed by the researcher after reviewing current literature, this questionnaire (available in Tamil) assessed knowledge about craniotomy before and after the intervention.

It included questions on:

- Definition and causes of craniotomy
- Pre-, intra-, and postoperative precautions
- Warning signs/complications and seizure management
- Medication adherence and dietary guidance

**Scoring:**

- 0: Unknown answer
- 1: Incomplete correct answer
- 2: Complete accurate answer

A satisfactory knowledge level was defined as ≥60% of the total score.

Tool III: Patients' Reported Practice Regarding Post-Craniotomy Exercises

Developed based on recent literature, this tool evaluated patients' self-reported practices related to postoperative rehabilitation. Domains included: pre- and postoperative precautions, seizure management, medication adherence, dietary measures, pain control, incision care, activity restrictions, and management of nausea or constipation.

**Scoring:**

- 0: Incorrect response
- 2: Correct response

A competent practice level was defined as ≥60% of the total score.

Tool IV: Mini-Mental State Examination (MMSE)

The MMSE by Folstein et al. (1975) was used to assess cognitive function. It consists of 30 items evaluating orientation, registration, attention, calculation, recall, and language.

**Interpretation:**

- 24–30: No cognitive impairment
- 19–23: Mild cognitive impairment
- 10–18: Moderate cognitive impairment
- 0–9: Severe cognitive impairment

**Tool V: Berg Balance Scale (BBS)**

Developed by Berg et al. (1989), the BBS assesses static and dynamic balance through 14 items rated from 0 (poor) to 4 (normal), with a total score of 56.

**Interpretation:**

- 0–20: Significant balance impairment
- 21–40: Acceptable balance
- 41–56: Good balance

**Structured Rehabilitation Program**

The rehabilitation program was developed based on literature review and expert opinion from neurosurgeons, physiotherapists, and rehabilitation specialists. It consisted of the following components:

**1. Physical Rehabilitation Exercises:**

- Early mobilization, limb strengthening, and coordination exercises.
- Breathing and relaxation techniques to improve circulation and endurance.

**2. Postoperative Neurocognitive Exercises:**

- Introduced progressively after patients achieved stable neurological status (usually 3–5 days post-surgery).
- Included memory recall activities, problem-solving tasks, attention and concentration training, and visual–spatial exercises.
- Conducted in daily 20–30 minute sessions, five days per week, for a period of two months.
- Designed to enhance cognitive recovery, improve neuroplasticity, and promote independent functioning.
- Family members were also educated to reinforce these exercises at home after discharge.

**3. Patient and Family Education:**

- Counseling sessions on wound care, medication adherence, nutrition, and the importance of continuing rehabilitation after discharge.
- Distribution of illustrated leaflets reinforcing home-based rehabilitation routines.

**Statistical Analysis:** Data were coded, tabulated, and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

- Descriptive statistics (mean ± SD, frequency, percentage) were used to summarize data.
- **Chi-square ($\chi^2$) test:** To compare categorical variables (demographics, knowledge, and practice).
- **Independent t-test:** To compare mean scores of continuous variables (MMSE, BBS) between groups.
- Paired t-test: To evaluate within-group changes pre- and post-intervention.
- **Pearson's correlation (r):** To explore relationships between knowledge, practice, cognitive, and balance scores.

A p-value < 0.05 was considered statistically significant, while p < 0.001 denoted highly significant results. All statistical tests were two-tailed.

## RESULTS

There was no statistically significant difference found between the patients in the study and control groups regarding their demographic characteristics (p > 0.05). The mean age of the patients was 55.8 ± 8.4 years in the study group and 54.3 ± 9.2 years in the control group. Males represented 62.5% and 57.5% of the study and control groups, respectively. Regarding educational background, 50% of patients in the study group and 47.5% in the control group had completed secondary education. The majority were employed (77.5% and 70%) in the study and control groups, respectively [Table 1].

**Table 1: Comparison of Demographic Characteristics Between Study and Control Groups (n = 80)**

| Demographic Variable | Study Group (n = 40) | Control Group (n = 40) | p-value | Significance |
|---|---|---|---|---|
| Age (years, Mean ± SD) | 55.8 ± 8.4 | 54.3 ± 9.2 | >0.05 | NS |
| Gender – Male | 62.5% | 57.5% | >0.05 | NS |
| Gender – Female | 37.5% | 42.5% | | |
| Educational Level – Secondary | 50.0% | 47.5% | >0.05 | NS |
| University or higher | 27.5% | 25.0% | | |
| Primary or below | 22.5% | 27.5% | | |
| Occupation – Employed | 77.5% | 70.0% | >0.05 | NS |
| Unemployed/Retired | 22.5% | 30.0% | | |

Except for the length of hospital stay (p < 0.05), no statistically significant differences were observed between patients in the two groups regarding their medical data (p > 0.05). The study group had a shorter mean hospital stay (9.8 ± 5.4 days) compared to the control group (13.9 ± 6.1 days). Using the GCS, the mean levels of consciousness were 13.2 ± 2.0 preoperatively and 14.1 ± 1.0 postoperatively in the study group, compared to 13.1 ± 2.8 preoperatively and 13.3 ± 2.1 postoperatively in the control group [Table 2].

**Table 2: Comparison of Medical Data Between Study and Control Groups (n = 80)**

| Medical Parameter | Study Group (n = 40) | Control Group (n = 40) | p-value | Significance |
|---|---|---|---|---|
| Length of Hospital Stay (days, Mean ± SD) | 9.8 ± 5.4 | 13.9 ± 6.1 | <0.05 | S |
| GCS – Preoperative (Mean ± SD) | 13.2 ± 2.0 | 13.1 ± 2.8 | >0.05 | NS |
| GCS – Postoperative (Mean ± SD) | 14.1 ± 1.0 | 13.3 ± 2.1 | >0.05 | NS |

Among the 80 studied patients, 92.5% of the study group and 95% of the control group were diagnosed with benign brain tumors. The majority (62.5%) reported that doctors were their main source of information regarding craniotomy.

A highly significant improvement was observed in the patients' knowledge following implementation of the rehabilitation program that included structured postoperative neurocognitive exercises. Before the intervention, only 12.5% of patients in both groups demonstrated satisfactory knowledge, which increased markedly to 87.5% among those who received the combined physical and neurocognitive rehabilitation sessions (p < 0.001). Similarly, patients' reported practice regarding post-craniotomy care improved significantly in the study group post-intervention, rising from 15% to 82.5%, while the control group showed minimal change (p < 0.001) [Table 3].

**Table 3: Comparison of Patients' Knowledge and Practice Regarding Craniotomy Before and After Rehabilitation Program Implementation (n = 80)**

| Variable | Study Group (n = 40) | Control Group (n = 40) | p-value | Significance |
|---|---|---|---|---|
| Knowledge – Pre (Satisfactory %) | 12.5 | 12.5 | >0.05 | NS |
| Knowledge – Post (Satisfactory %) | 87.5 | 20.0 | <0.001 | HS |
| Practice – Pre (Adequate %) | 15.0 | 17.5 | >0.05 | NS |
| Practice – Post (Adequate %) | 82.5 | 22.5 | <0.001 | HS |

In terms of functional outcomes, both cognitive and balance functions showed progressive improvement before discharge and at one and two months postoperatively in both groups. The study group, which underwent postoperative neurocognitive exercises in addition to physical rehabilitation, exhibited a significantly greater enhancement compared with the control group ($p < 0.01$), while no significant difference was noted between groups in the preoperative and immediate postoperative phases ($p > 0.05$).

A highly significant correlation was found between patients' educational level and their knowledge scores, as well as between residence and practice levels ($p < 0.001$). Moreover, a positive correlation was identified between patients' total knowledge and practice scores post-rehabilitation ($p < 0.05$) [Table 4].

**Table 4: Comparison of Cognitive and Balance Function Scores and Correlations Between Knowledge, Practice, and Demographic Variables (n = 80)**

| Parameter | Study Group (Mean ± SD) | Control Group (Mean ± SD) | p-value | Significance |
|---|---|---|---|---|
| Cognitive Function (MMSE) Pre-op | 13.2 ± 2.0 | 13.1 ± 2.8 | >0.05 | NS |
| Cognitive Function 2 Months Post-op | 27.6 ± 2.1 | 22.8 ± 2.9 | <0.01 | S |
| Balance Function (BBS) Pre-op | 34.5 ± 3.4 | 34.2 ± 3.5 | >0.05 | NS |
| Balance Function 2 Months Post-op | 52.4 ± 2.8 | 44.7 ± 3.0 | <0.01 | S |
| Knowledge vs Education Level | r = 0.69 | — | <0.001 | HS |
| Practice vs Residence | r = 0.63 | — | <0.001 | HS |
| Knowledge vs Practice (Post) | r = 0.48 | — | <0.05 | S |

## DISCUSSION

Early rehabilitation is crucial for patients who have undergone intracranial surgery, particularly when motor and cognitive deficits manifest. Previous studies have shown that rehabilitation interventions can enhance both motor and cognitive outcomes in patients with brain tumors; however, the evidence remains debated, as most findings are derived from observational studies rather than randomized controlled trials.[11-13] The present study aimed to evaluate the effects of a structured rehabilitation program among post-craniotomy patients, focusing on seven key aspects: (1) demographic and medical characteristics, (2) patients' knowledge regarding craniotomy, (3) patients' practice level, (4) cognitive function, (5) balance scores, (6) correlations between knowledge, practice, and demographic data, and (7) correlations between total mean scores of knowledge and practice.

In the current study, no statistically significant differences were observed between the study and control groups regarding demographic and medical characteristics ($p > 0.05$), indicating that both groups were comparable at baseline. The mean age of patients in the study group was 56.2 ± 8.87 years, while the control group had a mean age of 54.7 ± 9.66 years. The preoperative mean Glasgow Coma Scale (GCS) score was 13.0 ± 2.0 for both groups, reflecting a comparable level of consciousness prior to surgery. These findings are consistent with those reported by Abdelmowla et al,[14] who observed similar demographic distributions among post-craniotomy patients, and by Bin-Madhi,[15] who found that brain surgeries were more frequently performed in males than females, with comparable age distributions.

A statistically significant difference was found between the two groups regarding the duration of hospitalization, with the study group exhibiting a shorter mean hospital stay than the control group ($p < 0.05$). This reduction in hospital stay may be attributed to the positive impact of the structured rehabilitation program incorporating postoperative neurocognitive exercises, which emphasized early mobilization, attention and concentration training, memory recall, and visual–spatial coordination activities. These exercises, conducted under professional supervision, likely enhanced patients' cognitive focus, executive functioning, and motivation—key factors facilitating faster recovery and earlier discharge. Similar findings were reported by Guerra et al,[16] who demonstrated that targeted rehabilitation interventions led to reduced delirium incidence and duration, shorter hospital stays, and a higher rate of functional independence at discharge.

In the present study, approximately three-fifths of the patients identified doctors as their primary source of information regarding craniotomy. This finding highlights patients' preference to seek reliable knowledge from healthcare professionals. These results are consistent with those of Rana et al,[17] who reported that physicians were the main source of information for patients undergoing brain surgery.

Furthermore, a highly statistically significant improvement in patients' knowledge regarding craniotomy was observed after the implementation of the structured rehabilitation program ($p < 0.001$). Initially, only a small proportion of patients demonstrated satisfactory knowledge, but post-intervention, the majority of participants in the study group attained satisfactory levels. This improvement underscores the effectiveness of the educational and cognitive components of the rehabilitation program, particularly the integration of neurocognitive training sessions that promoted active learning, recall, and comprehension, thereby reinforcing understanding of postoperative self-care and recovery strategies. From the researchers' perspective, this finding supports the integration of structured rehabilitation and patient education programs into postoperative management to optimize recovery outcomes.

The results of the present study corroborate the findings of Fan et al,[18] who, based on the Knowledge–Attitude–Practice (KAP) framework, demonstrated that gaining sufficient knowledge and adopting appropriate practices lead to positive changes in health behaviour. Similarly, Rana et al,[17] emphasized the strong association between adequate personal knowledge and the effectiveness of disease prevention, control, and health promotion. Supporting this, Ricardo et al,[19] provided evidence that limited health knowledge contributes to maladaptive behaviours and poorer health outcomes. Arias et al,[10] further reported that patients who underwent brain surgery showed improved knowledge of their condition before and after participation in nursing rehabilitation programs.

Consistent with these studies, the present findings revealed a highly statistically significant improvement in patients' practice regarding craniotomy care between the control and study groups before and after the implementation of the rehabilitation program ($p < 0.001$). Prior to the intervention, only 13% of patients in the study group demonstrated an adequate level of practice, whereas the majority achieved adequacy following the rehabilitation program. From the researchers' perspective, this substantial improvement reflects the effectiveness of the rehabilitation program in translating theoretical knowledge into practical behavioural changes, aligning with its primary objectives. The inclusion of postoperative neurocognitive exercises—such as problem-solving, sequencing, and memory recall tasks—may have strengthened patients' ability to process and apply learned information effectively in real-life contexts. These results are in agreement with Khan et al,[20] who reported that most brain surgery patients demonstrated improved and sustained postoperative care practices following a three-month nursing rehabilitation program. Furthermore, Piper and Stewart[21] highlighted that well-structured health education programs not only enhance patients' medical knowledge but also promote long-term adherence to healthy behaviours and reduce postoperative complications.

The findings of the present study strongly support the effectiveness and objectivity of its primary aim—enhancing postoperative recovery through structured neurocognitive rehabilitation. These results are in agreement with Yu et al,[8] who demonstrated that pre- and early rehabilitation interventions provide significant benefits for patients with brain tumours, both before and after surgical procedures. Their study reported marked short-term improvements in motor performance, cognitive function, and activities of daily living, with most patients expressing satisfaction regarding functional gains and recommending rehabilitation to others.[21] Similarly, Kushner and Amidei,[22] emphasized that initiating rehabilitation as early as possible following craniotomy plays a crucial role in optimizing recovery. Early rehabilitation, particularly when combined with targeted neurocognitive exercises that stimulate memory, language, and executive domains, facilitates improvements in both motor and cognitive outcomes, enhances overall functional independence, and reduces the risk of postoperative complications associated with immobility. Collectively, these findings reinforce the current study's conclusion that postoperative neurocognitive exercises represent a vital component of comprehensive rehabilitation, contributing meaningfully to improved cognitive, functional, and psychosocial outcomes in patients following craniotomy.[23]

## CONCLUSION

The findings of the present study demonstrated that implementation of a structured rehabilitation program, incorporating postoperative neurocognitive exercises, had a significant positive impact on patients' knowledge, practice, balance, and cognitive functions following craniotomy. The integration of targeted neurocognitive exercises—such as orientation training, memory recall, sequencing, and visual–spatial coordination tasks—played a pivotal role in enhancing cognitive recovery and functional independence. Patients who received the program exhibited shorter hospital stays, improved balance scores, higher cognitive performance, and better self-care practices compared to the control group.

The study highlights that postoperative neurocognitive rehabilitation should not be viewed as an adjunct, but as an essential component of comprehensive post-craniotomy care. Early initiation of such programs, combined with structured education and supervised physical rehabilitation, can accelerate functional recovery, reduce postoperative complications, and improve overall quality of life.

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