Effect of Rehabilitation Program on Practice, Balance, and Cognitive Functions for Patients Post Craniotomy

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Abstract

Background: Functional, behavioral, and cognitive disabilities often contribute to the difficulties in rehabilitation programs of patients post-craniotomy. **Aim:** Determine the effect of rehabilitation program on Practice, Balance, and Cognitive Functions for Patients post-craniotomy. **Subjects and Methods:** Quasi-experimental research design was used**. Setting:** This study was carried out at the neurosurgery department and outpatient clinic at Mansoura University Hospital. A purposive sample of 70 oriented patients post craniotomy were classified into the study (who received the rehabilitation program) and the control group (35 in each group). **Tools:** (I) Patients' assessment sheet post craniotomy, (II): Patients' knowledge regarding craniotomy (pre and post-rehabilitation), (III): Patients' reporting practice regarding post-craniotomy exercise, (pre and post-rehabilitation), (IV) Mini-mental state examination (MMSE), and tool(V) Berg Balance scale(BBS). **Results:** In comparison to patients in the control group, participants in the study group showed a statistically significant increase in their knowledge**,** practice**,** cognitive, and balance abilities following the rehabilitation program (p. value < 0.01). **Conclusion:** When a rehabilitation program is implemented, patients' knowledge, practice, and cognitive and balance abilities after a craniotomy significantly improve. **Recommendation:** All patients who have had a craniotomy should participate in a rehabilitation program.

Keywords: Craniotomy, cognitive and balance functions & rehabilitation program

Introduction:

Significant morbidity and death are still associated with primary brain tumors, despite advancements in their care. Maximal tumor excision, followed by adjuvant chemotherapy or radiation, is currently the standard care for patients who are newly diagnosed with brain tumors (**Tan et al., 2020**). For the removal of brain tumors, craniotomies are the most often performed surgical operation. The brain is accessed during a surgical procedure that involves removing a bone flap from the skull. Following a craniotomy, patients should have regular and comprehensive nursing assessments. These assessments should concentrate on the possibility of neurological impairment due to an effusion, hematoma, seizure, hydrocephalus, or prolonged hypertension **(Xu et al., 2020)**. Because brain tumors are infiltrative and have a short postoperative course that is frequently complicated with major adverse events, which cause an extended hospital stay, reoperation, and readmission, striking a balance between the maximal resection of the brain tumors and the preservation of neurological function can be difficult (**Krivosheya et al., 2020**). Postoperative neurological deficits sometimes have unclear causes, and it can be challenging to forecast how quickly function will decrease. Preoperative evaluation can provide more accurate information about the results of surgery after surgery **(Zetterling et al., 2020)**.

Following a craniotomy, many patients have some degree of physical or cognitive abnormalities. Patients become more easily distracted and have slower processing speeds for information. There can be variable effects on cognitive processes like memory, focus, and attentiveness as well as fatigue. During their recuperation, a lot of patients have lightheadedness and imbalance issues. Impaired balance might limit a patient's ability to participate in social activities and daily living activities. Establishing the degree of cognitive and physical impairments is essential to creating an appropriate rehabilitation strategy **(Abu-Hegazy & El-Hadaad, 2019 & Alashram et al., 2020)**.

It is possible to treat those symptoms with cognitive and physical rehabilitation. After a craniotomy, neurosurgery nurses play a proactive and useful part in their patients' rehabilitation. Important methods for providing care for patients after a craniotomy are rehabilitation and nurse administration. According to **Li et al., (2019**), it can lower the rate of disability and enhance patients' mental health and quality of life. Restoring independence is the main goal of rehabilitation after intracranial surgery to remove a brain tumor, with a focus on mobility, daily activities of living, cognition, and communication. The prehabilitation objectives change based on the issues that patients face. Early rehabilitation is necessary to accomplish the set objectives, avoid difficulties, and produce better results **(Yu et al., 2019)**.

Significance of the study

The literature indicates that patients treated with a craniotomy to remove a brain tumor frequently experience balance and attention problems. Deficits in equilibrium and focus may limit the patient's ability to do daily tasks and engage in social interactions. The prevalence of brain tumors in African countries has been estimated to be 226.98 /100,000 population. There is a significant difference in the distribution of CNS tumors across Africa, with Nigeria having the highest number of cases, followed by Egypt **(Aderinto et al., 2023).** The impact of rehabilitation on balance and attention after craniotomy for brain tumor removal has not been extensively studied up to this point, so the purpose of this study was to enhance the cognitive and balance abilities of patients who had had craniotomies. 210 people were admitted to the neurosurgery department and treated with craniotomies, according to hospital data at the Neurological, and Neurosurgery department for one year **(Mansoura University Hospital Record, 2020)**.

Operational Definitions

Cognitive function: is a broad term that refers to involved in acquisition, information manipulation, and knowledge gain. The domains of perception, memory, learning, attention, decision-making, and language skills are all included in cognitive functioning **(Fujishiro et al., 2019).**

Rehabilitation: is defined as a process of a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment. **(Arias, et al., 2022).**

Aims of the study:

Determine the effect of the rehabilitation program on Practice, Balance, and Cognitive Functions for Patients post-craniotomy through:

- Assessing patients' knowledge regarding craniotomy.
- Defining patients' practices regarding craniotomy.
- Assessing patients' balance and cognitive functions pre and post-craniotomy
- Designing and implementing a rehabilitation program according to patients' needs.
- Evaluating the effect of rehabilitation programs regarding craniotomy on patients' knowledge, practices, balance, and cognitive functions.
- Assessing the relationship between patients' knowledge and practice about craniotomy and their demographic characteristics.
- Finding out the correlation between knowledge and practice among patients' post-craniotomy

Research Hypothesis

H1: Patients' knowledge levels are expected to improve post-rehabilitation program in the study group than in the control group.

H2: Patients' practice levels are expected to improve post- rehabilitation program in the study group than in the control group.

H3: Patients' balance and cognitive functions are expected to be improved in a rehabilitation program in the study group than in the control group.

Subjects & Methods

The researchers utilized a quasi-experimental design to carry out their study.

Setting:

The study took place at the neurosurgery department outpatient clinic at Mansoura University Hospital.

Sample

A purposive sample of 70 oriented patients post craniotomy were classified into two groups (35 in each group) the study group (which received the rehabilitation program) and the control group (which received routine care) were chosen to participate in the study. before the craniotomy, after the surgery, before the patient was discharged, and one to two months post- operative, cognitive and motor abilities were evaluated. Knowledge and practice were measured pre and post-surgery.

Sample calculation:

The number of participants was calculated based on the following formula (https:// byjus. com/ sample- size-formula/).

$$n = \frac{T^2 \times p(1-p)}{m^2}$$

Description:

n = required sample size.

t = confidence level at 95% (standard value of 1.96).

p = estimated prevalence of patients post craniotomy 2018 at CUSPH =0.76)

m = margin of error at 5% (standard value of 0.05).

Inclusion Criteria

- Age 18- 65 years old
- Newly admitted patients and planned treatment with craniotomy.
- Patients who not receiving rehabilitation programs from the hospital.
- Conscious patient who oriented to place, person, and time (GCS scale score range from(14-15).
- Patients who accept to participate in the study.

Exclusion Criteria

- Patients with memory problems, dementia, epilepsy, and aphasia.
- Disturbed level of consciousness.
- patients who are cognitively unable to follow directions.
- Patients with a previous history of brain surgery.

Tools:

Tool I: Patient assessment sheet post craniotomy:

It included two parts:

- **Part (1):** It was used to assess patients` demographic data such as age, education, residence, and occupation.

- **Part (II): Medical history:** to determine the type of brain tumor, diagnostic investigations, duration of hospitalization, and

Level of consciousness(GCS) was employed using GCS developed by **Teasdale & Jennette (1974)** to assess the level of consciousness.

Tool (II): Patients' knowledge, regarding craniotomy (pre and post-test format): This tool was developed by the researcher based on reviewing the recent related literature **(Zetterling et al., 2020, Xu et al., 2020, & Tan et al., 2020)**. It was developed and written in Arabic language. It is composed of open and closed-ended questions to assess patients' knowledge regarding craniotomy before and after rehabilitation program related to the definition of brain surgery, definition of craniotomy, causes for craniotomy, pre and postoperative precautions, perioperative care and warning signs/complications to be reported to the doctor, how to deal with seizure(s), knowledge related to medication prescription, dietary measures.

Scoring system:

The following tool was used to grade the study patients' knowledge: 0 for unknown answers, 1 for incomplete correct answers, and 2 for complete accurate answers. Every correct response, which varied depending on the question, had to be chosen by the researcher. All scores will be expressed as percentages. Unsatisfactory knowledge was defined as less than 60% of the total knowledge score, while satisfactory knowledge was defined as equal or more than 60% of the total knowledge score.

Tool (III): Patients' reporting practice regarding post-craniotomy exercises (pre and post-test format): This tool was developed by the researcher based on reviewing the recent related literature **(Krivosheya et al., 2020, Xu et al., 2020, & Tan et al., 2020).** It was used to evaluate patients' reporting practice after the rehabilitation program post craniotomy such as pre and postoperative precautions, perioperative preparation, how to deal with seizure(s), prescribed medication, dietary measures, pain control, incision care, lifting, activity, driving, experience nausea and constipation.

Scoring system:

Patients who participated in the study were given scores based on their Practices: 0 for an incorrect response and 2 for a correct response. Every correct answer, which varied for every question, had to be chosen by the patients. All scores will be expressed as percentages Competent practices accounted for less than 60% of the total practice score, whereas incompetent practices equaled or more than 60% of the total practice score **El-Sayed, et al.,2019).**

Tool IV**: Mini-mental state examination** (**MMSE**)**:** It was adopted from **Folstein et al., (1975**). A 30-item questionnaire was utilized to evaluate the following aspects of cognitive function: language, registration (repeating named cues), attention, computation, recall, basic command following, and orientation. 30 is the total score. In terms of cognitive impairment, a score of 24–30 indicates no impairment, 19–23 indicates mild impairment, 10–18 indicates moderate impairment, and 0–17 indicates severe impairment.

Tool V**: Berg balance scale (BBS):**

It was created by **Berg et al. (1989**) to assess adults' static and dynamic balancing abilities. Through the completion of practical tasks, balance ability was assessed. The test consisted of 14 items that were split into 3 categories of functional activities: dynamic balance (5 items), standing balance (8 items), and seated balance (1 item). Every item has a five-point rating system, with 0 denoting the lowest function level and 4 the greatest function level. For every score (which can range from 0 to 56), a sum is calculated. Reduced fall risk = higher score. With a score of 0–20, balance impairment is indicated, 21–40, acceptable balance, and 41–56, good balance

Validity of the tools

Five experts in the fields of medical-surgical nursing and neurosurgery evaluated the tool's content validity, testing it for appropriateness, clarity, comprehensiveness, and relevance. These experts included two professors and two assistant professors of medical-surgical nursing staff, Mansoura University, as well as one professor of neurosurgery staff, faculty of medicine , Mansoura University. To guarantee sentence visibility and study topic appropriateness, no changes were made to the study material.

Reliability of the used tools

The conventional criterion of a kappa statistic (k) above 0.6 was used to evaluate the reliability of GCS, which was employed in tool I. Tool II using the 0.95 correlation coefficient. Tool IV is determined by correlation coefficient (0.78) and Tool III by Cronbach's alpha test (0.98).

Method:

The Preparatory phase:

It included reviewing current, past, local, and international related literature and theoretical knowledge of various aspects of the study using books, articles, the internet, periodicals, and magazines to develop tools for data collection. The developed tools were examined by experts to test their reliability to the study.

A pilot study:

To make sure the research instruments were visible, applicable, and took the necessary amount of time to complete, it was tested on 10% (7 patients). No changes were made to the pilot study's findings. Patients who participated in the pilot study were excluded from the study.

Ethical considerations

The scientific research ethics committee of the nursing faculty and the hospital directors of the neurosurgery department at the neurology and neurosurgery department of Mansoura University Hospital were consulted before the research was carried out. After informing the patients of the study's purpose, a verbal informed consent was acquired for them to participate. Patients were told by the researchers that participation in the study was entirely optional and that they might leave at any moment, for any reason, They also guaranteed the privacy of their data.

Administrative phase:

An official letter of approval was obtained from the Dean of the Faculty of Nursing, Mansoura University Hospital to conduct the study after a full explanation of the study's aim. The letter involved an agreement to perform the study at the previously selected setting.

Fieldwork:

From the beginning of September 1st, 2023 to the end of December 2023 data collection took place, three days a week, the patients were met by the researchers in the previously described setting, and each interview lasted roughly 20-25 minutes. In the initial meeting with the studied patients, the researchers gave an introduction, covered all the details of the study's goals, duration, and procedures, and obtained a verbal consent. After completing the pretest during the initial meeting, the researchers provided a booklet to each participating studied patient and explained the contents of the program.

- The study was implemented throughout three phases: assessment, implementation, and evaluation.

I-Assessment phase:

The assessment phase is the first step of the rehabilitation program which includes a pre-test for gathering information concerning the patient's data by Study tools I, II, and III. The MMSE scale (tool IV) and the BBS (tool V) were used to measure the balance and cognitive functions for study and control group as pretest to validate the presence of mild attention deficit and poor balance in patients before and after craniotomy which was confirmed by the diagnosis of neurosurgeons.. The assessment identifies current and future care needs and prioritizes interventions. The researchers took between 12 and 15 minutes to complete each instrument. Following surgery, the control group received standard hospital care such as (neurological examination, family members were told to talk to their patients and point them in different directions to get their attention), while the study group additionally received a rehabilitation program (a teaching booklet).

After surgery, patients underwent a post-test (follow-up) to evaluate patients' knowledge, practices, Balance &cognitive functions two months following the implementation of the rehabilitation program.

II. Implementation Phase:

After the relevant literature was evaluated in light of the assessment of the real patients' demands for strengthening their balance and cognitive abilities following cranial surgery, a simplified booklet (rehabilitation program) was employed as a support and delivered to patients in Arabic, Under the direction of of **Freire et al., (2011); Trivedi et al., (2014); Church, (2020); and Maher, (2020).** It covered the following topics:

- Techniques to sustain focus, orientation, and cognitive abilities.
- Techniques to sustain early socialization and mobilization.
- Exercises for attentionand concentration:

Enhancing balance and cognitive functions in individuals with brain tumors after craniotomy was the aim of the rehabilitation program that started immediately during postoperative period. The content, intensity, and frequency of the rehabilitation program are customized to meet the clinical demands of the patient. The rehabilitation group was assigned to morning and afternoon shifts, with four theoretical and practical sessions per day. (one hour for each one).

- **In the first session** Patients' knowledge was covered in the theoretical section including the definition of brain surgery, the definition of craniotomy, causes for craniotomy, pre and postoperative precautions, perioperative care and warning, signs/complications, how to deal with seizure(s), knowledge related to prescribed medication, and dietary measures.
- . **Second session:** focused on practical section included information about pre and postoperative preparations, perioperative preparation, dealing with seizure(s), prescribed medication, Dietary measures, pain control, incision care, lifting, activity, driving, and experiencing nausea and constipation.
- **The third session** of brain rehabilitation focused on cognitive and concentration skills. The patient's capacity to pay attention and concentrate on multiple tasks at once was enhanced by these workouts. It was done once per day for two months. It consisted of the following: using your non-dominant hand, practicing fine motor skills, matching rhythms, repeating numbers and letters, sitting outside, and journaling.
- **Fourth session:** focused on brain rehabilitation exercises involving core and balance: This improved gait and coordination. For two months, it was done once a day. Included weight shifts, sitting trunk extension, Romberg stance, calf lifts, forward punches, staggered stance, and core toe taps. Lateral trunk flexion (also known as oblique crunches) was also included. Because each activity was documented by the patient or a family member, the rehabilitation program's implementation status could be verified.

Under the guidance and support of the researchers, patients received instruction and trained on how to do exercises. To help patients finish their rehabilitation program correctly and successfully and maintain a faster recovery, caregivers, and family members were invited to join the sessions and receive education on the rehabilitation program. Patients were directed to finish the two-month rehabilitation period by performing the exercises once a day at home under family supervision.

III. Evaluation phase:

Patients were re-interviewed (post-test) using the same tools used in the pretests II III, IV, and V for assessing patients before discharge, post two months for the study and control groups. In the outpatient neurosurgery clinic, follow-up was conducted at the 2-month follow-up mark.

Statistical analysis:

Data analysis was done using the statistical program for social sciences, version 21.0. Data on the personal and medical histories of the patients in both groups were compared using the independent t-test and chi-square test. The independent sample t-test verified the significance of the balance and attention improvements comparison between the rehabilitation and control groups. The program's overall satisfaction with gains in balance and cognitive functioning, activities of daily living, rehabilitation intensity, and recommendation of a rehabilitation program to other patients was measured using the Chi-square test. A ($p<0.05$) for statistical significance was selected

Results

According to **Table (1),** there was no statistically significant difference found between the patients in the study and control groups concerning their demographic attributes (p. value > 0.05). They were, respectively, 56.2±8.87 and 54.7±9.66 years old on average. Males made up 60% and 54.28% of the group, respectively. Additionally, the study and control groups had the same educational backgrounds: 51.42% and 45.71%, respectively, had secondary education, and 80% and 68.58%, respectively, were working.

Table (2) illustrated that, except for length of hospital stay (p. **value<0.05), no** statistically significant differences were observed between patients in the study and control groups concerning medical data (p. value > 0.05). The study group's patients had a shorter mean length of hospital stay [9.44±5.76 and 13.65±6.33 days, respectively] than the control group. Using the GCS, the mean scores levels of consciousness were 13.0±2.1 before surgery and 14.0±1.1 after in the study group compared to 13.0±3.0 pre and13.0±2.0 post in the control group.

Figure (1): Reveals that (90.0%) and (97.0%) respectively were diagnosed with benign brain tumors among the studied patients in both the study and control groups.

Figure (2) highlighted that (60%) of the studied patients reported that the main source of knowledge regarding craniotomy was doctors.

Table (3) illustrated that a highly statistically significant difference was found between the patient's knowledge regarding craniotomy between the control and the study group pre and post-(rehabilitation) program implementation at (P<0.001).

Figure (3) shows that (12%) of the studied patients in the study and control group had a satisfactory level of knowledge regarding craniotomy in the pre-rehabilitation but post-rehabilitation program implementation had improved and become (85%).

Table (4) illustrated that a highly statistically significant difference was found regarding the patients' practices about craniotomy between control and the study groups pre and post-rehabilitation program implementation at (P<0.001).

Figure (4) shows that (13%) of the studied patients in the control group had an adequate level of practice regarding craniotomy in the pretest but post-rehabilitation program implementation (80%) had an adequate level of practice in the study group.

Table (5): demonstrated that before discharge, one month, and two months after surgery, there was a discernible improvement in the mean score in both the study and control groups. When compared to the control group, the study group's improvement was, nevertheless, statistically significant (p. value < 0.01). Furthermore, there was no statistically significant difference found in the mean score for cognitive function between the patients in the two groups before surgery and immediately after surgery (p. value > 0.05).

Table (6): showed that there was a noticeable improvement in both groups' mean scores before discharge as well as one and two months after surgery. But compared to the control group, the study group showed significantly more progress (p. value < 0.01). However, when it came to the mean score for balancing ability, there was no statistically significant difference between the patients in the study and control groups (p. value > 0.05) during preoperative and Immediate postoperative Balance.

Table (7): Showed that there was a highly statistically significant correlation between the knowledge and educational level of the patients in the study. Additionally, there was a correlation between patients' residence and practice at (P value <0 .001).

Table (8): describes that a statistically significant positive correlation was detected between the studied patients' total practice and knowledge post-rehabilitation program implementation at p<0.05.

Table (1): Demographic characteristics of the studied patients in both study and control groups (n=70)

Variables	study Group (n=35)		Control Group (n=35)		P- value
	No.	%	No.	%	
Age (years) Mean ± SD	56.2±8.87		54.7±9.66		0.083
Sex					
Male	21	60.0	19	54.28	0.229
Female	14	40.0	16	45.71	
Level of education					
University	4	11.42	8	22.85	0.626
Secondary	18	51.42	16	45.71	
Primary	3	8.60	4	11.42	
Read and write	4	11. 42	5	14.28	
Illiterate	6	17.10	2	5.71	
Occupation					
Not working	7	20.0	11	31.42	0.251
Working	28	80.0	24	68.58	

Non significant p>0.05 Significant p<0.001

Table (2): Medical data distribution of the studied patients in the study and control groups(n=70)

Items of medical data	study Group (n=35)		Control Group (n=35)		P- value
	No.	%	No.	%	
Type of brain tumor					
Benign	32	90.0	34	97.0	0.076
Malignant	3	10.0	1	3.0	
Duration of hospitalization (Mean ± SD)	9.44±5.76		13.65±6.33		0.03*
Level of consciousness (Mean ± SD)					
Preoperative	13.0±3.0		13.0±2.1		0.063
Postoperative	14.0±1.0		14.0±1.1		

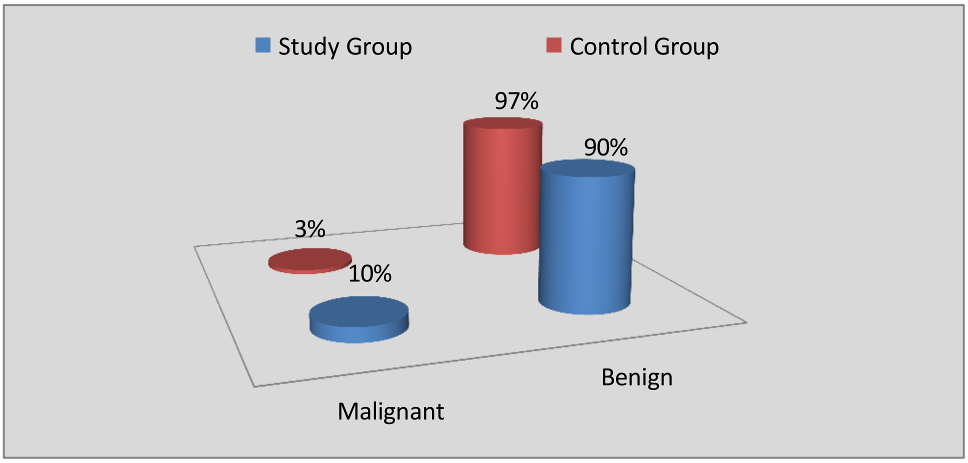

Figure (1): Distribution of the studied patients in the study and control groups regarding their brain tumor type.

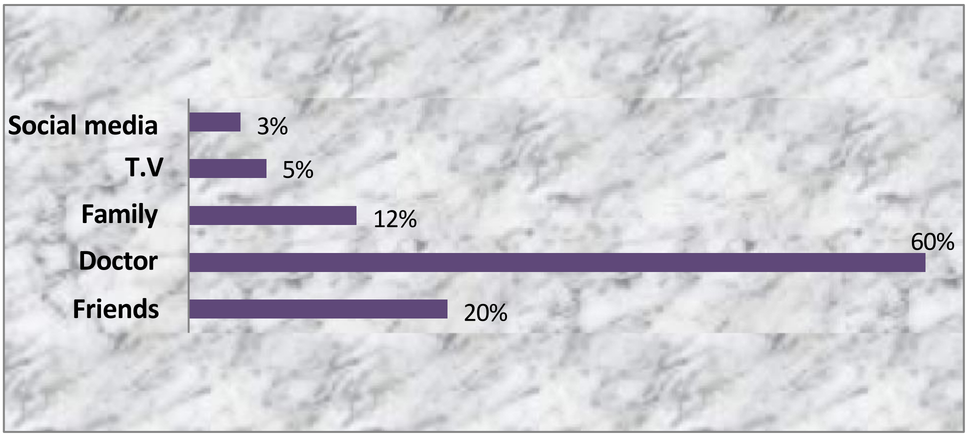

Figure (2): Source of knowledge regarding craniotomy among the studied patients (n=70)

Table (3): Patients' knowledge mean scores regarding craniotomy pre and post-rehabilitation program implementation (n=70)

Patients' knowledge	Control Group (n=35)	study Group (n=35)	Paired t-test	P value
Definition of brain surgery	.47±.56	1.85±.62	20.5	<0.001**
Definition of craniotomy	.75±.36	1.73±.56	31.6	<0.001**
Causes for craniotomy	.48±.52	1.45±.33	24.7	<0.001**
Pre and postoperative precautions	.72±.51	1.81±.45	34.8	<0.001**
Perioperative care and warning signs/complications	.54±.48	1.52±.46	11.06	<0.001**
How to deal with seizure(s)	.65±.47	1.34±.41	15.6	<0.001**
Knowledge related to prescribed medication	.54±.43	1.71±.41	25.4	<0.001**
Dietary measures	.38±.51	1.83±.31	21.8	<0.001**

P:**: Highly Statistically significant at p<0.001

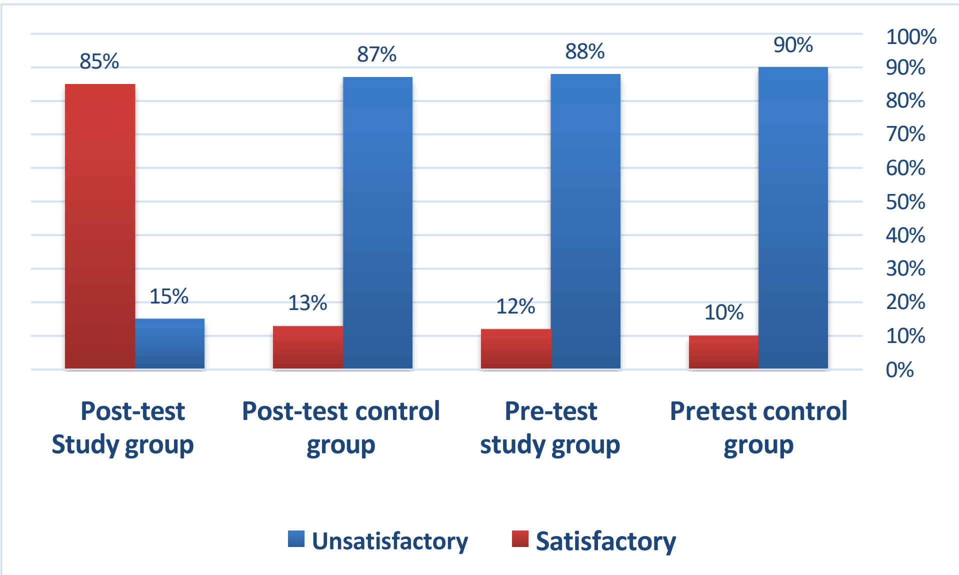

Figure (3): Total patients' knowledge level regarding craniotomy between control and study groups pre and post- rehabilitation program implementation (n=70).

Table (4) Comparison of the mean score among studied patients' practice level regarding craniotomy between control and study groups pre and post-rehabilitation program implementation (n=70).

Variable	Control Group (n=35)	Study Group (n=35)	Paired t-test	P-value
	Mean ±SD	Mean ±SD		
1. Pre and postoperative preparations	.67±.34	1.32±.53	54.4	<0.001
2.Perioperative preparation	.66±.71	1.76±.48	61.9	<0.001
3. dealing with seizure(s)	.60±.58	1.87±.71	55.5	<0.001
4. Prescribed medication	.45±.57	1.86±.57	20.6	<0.001**
5. Dietary measures	.67±.32	1.32±.53	54.4	<0.001
6. Pain control	.66±.71	1.76±.48	61.9	<0.001
7. Incision care	.60±.58	1.87±.71	55.5	<0.001
8. Lifting	.45±.55	1.86±.57	20.6	<0.001**
9. Activity	.67±.32	1.32±.53	54.4	<0.001
10. Driving	.66±.76	1.76±.48	61.9	<0.001
11. experience nausea and constipation	.60±.58	1.87±.71	55.5	<0.001

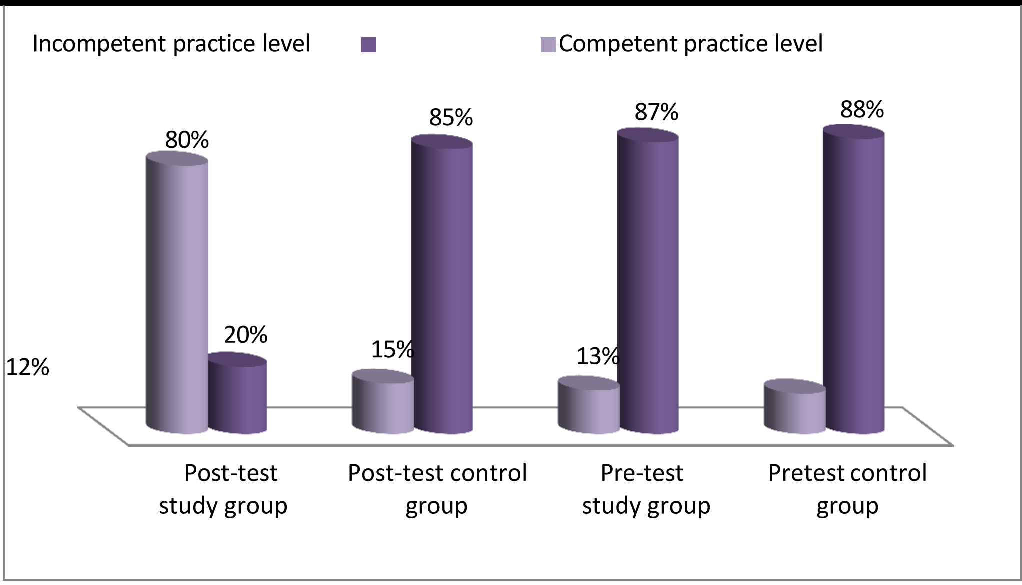

Figure (4): Total practice level regarding craniotomy pre and post-rehabilitation program implementation among the studied patients in control and study groups (n=70)

Table (5): Patients cognitive function mean scores among the studied patients in both study and control groups at different phases (n=70)

Time of Evaluation	Study group (n=35)	Control group (n=35)	P- value
	Mean ± SD	Mean ± SD	
Preoperative	18.4±1.8	18.3±1.7	0.245
Immediate postoperative	18.8±2.7	18.6±2.4	0.267
Before discharge	22.9±5.8	20.3±2.5	0.001**
1 month postoperatively	24.6±6.7	20.8±2.2	0.001**
2 months postoperatively	25.2±5.2	21.7±3.4	0.001**

Non significant p>0.05 Significant p<0.001

Table (6): Patients balance mean scores among the patients in both study and control groups at different phases of intervention (n=70).

Time of Evaluation	Rehabilitation group (n=35)		Control group (n=35)		P- value
	No.	%	No.	%	
Preoperative Balance impairment (0-20)	35	100	35	100	0.956
Mean ± SD	17.1±3.5		17.1±3.4		
Immediate postoperative Balance impairment (0-20)	35	100	35	100	0.934
Mean ± SD	17.2±3.5		17.3±3.8		
Before discharge					0.001**
Balance impairment (0-20)	-	-	1	3.0	
Acceptable balance (21-40)	35	100	34	97.0	
Good balance (41-56)	-	-	-	-	
Mean ± SD	33.5±2.6		28.4±65.8		
1 month postoperatively					0.001**
Balance impairment (0-20)	-	-	-	-	
Acceptable balance (21-40)	21	60.0	32	90.0	
Good balance (41-56)	14	40.0	3	10.0	
Mean ± SD	44.6±9.8		38.5±13.3		
2 months postoperatively					0.001**
Balance impairment (0-20)	-	-	-	-	
Acceptable balance (21-40)	3	10.0	21	60.0	
Good balance (41-56)	32	90.0	14	40.0	
Mean ± SD	46.6±9.9		42.7±9.7		

Non significant p>0.05 Significant p<0.001

Table (7): Correlation between total knowledge, practice, and their demographic characteristics among the patients in the study group (rehabilitation group) (n= 35)

Demographic characteristics		Knowledge	Practice
Age	R	-.125-	-.102-
	P – value	.351	.446
Educational level	R	**-.555**	.023
	P – value	**.001****	.877
Occupation	R	.063	**-.357**
	P – value	.617	**.015***
Residence	R	.044	**-.504**
	P – value	.749	**.001****

**. Correlation is significant at the 0.01 level

Table (8): Correlation between total mean scores of knowledge and practice regarding craniotomy among the patients in the study group pre and post-rehabilitation program implementation (n=35).

Items	Practice			
	Pre- Rehabilitation program implementation		Post- Rehabilitation program implementation	
	R	P	R	P
Knowledge	0.134	0.061*	0.246	0.000**

r: Pearson coefficient. **: Highly statistically significant at P< 0.001.

Discussion

When motor and cognitive deficits manifest, many patients who have undergone intracranial surgery require early rehabilitation. rehabilitation has demonstrated benefits in improving motor and cognitive abilities in brain tumor patients, however, it is still contentious; most of these benefits have come from observational studies rather than randomized controlled trials (**Zucchella et al., 2019**).

The seven key aspects of this study's discussion are as follows: data of the patients regarding demographic and medical health status; Patients' knowledge regarding craniotomy, patients' practice level regarding craniotomy, Patients cognitive function, Patients balance mean scores among the studied patients, Correlation between total knowledge, practice, and their demographic characteristics, and Correlation between total mean scores of knowledge and practice regarding craniotomy among the study group patients.

Results of the current study revealed that there were no statistically significant differences between the patients in the study and control groups regarding their demographic and medical data. from the researchers' point of view, it reflected the similarity of characteristics among both studied groups.

According to this study, the average age of the study group was 56.2±8.87 years, whereas the control group's mean age was 54.7±9.66 years For both groups, the preoperative mean GCS was13.0±2.0. The present study corroborates the findings of **Abdelmowla et al., (2017**), who investigated 124 patients following craniotomy, with a mean age of 37.5±18.5 years for the control group and 39.2±16.5 years for the study group. Males made up more than half of both studied groups, These results agree with a study by **BinMadhi, (2018**) entitled "Brain tumors excision guided by neuronavigation: Practical application and results" which revealed that brain surgery is more frequently undergone in males than females with the same mean age of years old.

Regarding the duration of hospitalization, a statistically significant difference was seen between the control and study groups. The control group was hospitalized for a longer period than the study group. According to the researchers, this might be because of how the patients in the rehabilitation group responded to the rehabilitation program. After applying the methods for maintaining direction, attention, and concentration as well as the strategies for maintaining early mobilization and socialization, the study group demonstrated a good improvement in attention and balance both throughout hospitalization and before discharge. Additionally, the daily physical activities performed while in the hospital under the guidance of researchers and patients' families (such as core and balance exercises and attention and concentration exercises) ultimately, help cut down on hospital stays.

Study results of **Guerra et al., (2015)** supported the present study result which showed that rehabilitation led to a decreased frequency and duration of delirium, fewer days spent in the hospital, and a higher likelihood of returning to an independent functional level upon discharge.

The result of the current study showed that three-fifths of the studied patients reported that the main source of knowledge regarding craniotomy was doctors. From the researchers' point of view, this result reflects that patients had the desire to seek information from health personnel. This Agreed with **Rana et al., (2020)** who stated that doctors were their primary source of information on brain surgery.

The current study illustrated that a highly statistically significant difference was found between the patient knowledge regarding craniotomy between the control and study group pre and post-rehabilitation program implementation in which more than ten percent of the studied patients in the study group had a satisfactory level of knowledge regarding craniotomy in the pre-intervention but post-rehabilitation program implementation had improved and the majority in the study group had a satisfactory level of knowledge. From the researchers' point of view, this result reflects the positive effect of t h e rehabilitation program, which met the studied patients' needs and provided them with sufficient knowledge.

This result corroborated the findings of the **Fan et al., (2020**) study regarding the "KAP theory" and showed that adopting the practice and obtaining the necessary knowledge alters health behavior. Furthermore, a new study by **Rana et al., (2020**) demonstrated the link between enough personal knowledge and successful illness prevention, control, and health promotion. A study by **Ricardo et al., (2018**) provided evidence that maladaptive disease and poor health are linked to a knowledge gap. Also, **Arias et al.,(2021)** stated that patients who had brain surgery had better knowledge of the procedure before and after nursing rehabilitation programs were implemented.

The present study findings indicated that a highly statistically significant difference was found regarding the patients' practices about craniotomy between control and study group pre and post-rehabilitation program implementation, in which thirteen percent of the studied patients in the study group had an adequate level of practice regarding craniotomy in the pretest but the majority post- rehabilitation program implementation had an adequate level of practice in the study group From the researchers' point of view, it reflected the significant modifications in the patient's practices that reflected the main goals of the implementation of the rehabilitation program This is in the same line with **Khan et al., 2019)**. who stated that the present study results revealed an improvement in brain surgery patients' practices and the majority of them had adequate practices post three-month nursing rehabilitation program implementation. Furthermore, **Piper & Stewart (2019),** reported that an efficient health education program leading changes that exhibit enhanced knowledge about special medical and health outcomes for a prolonged period and reduces several postoperative problems.

The current study's results revealed that there was no statistically significant difference between the study and control groups regarding cognitive function impairment at the preoperative and immediate postoperative stages following a craniotomy. From the researcher's point of view, it confirmed the positive effects of the rehabilitation program. According to **Singh et al., (2021)**, patients who had traumatic brain injury or intracranial surgery showed signs of cognitive impairment as measured by the MMSE. Many cognitive processes, including planning, paying attention, focusing, and solving problems, are interfered with by cognitive impairment.

According to **Dhandapani et al., (2019**) study results, individuals with intracranial tumors showed severe cognitive impairment, and following brain surgery, there was no improvement in cognitive function for six months. Following six months following intracranial surgery, patients' cognitive performance improved. Patients with cognitive impairment may experience difficulties with their attention, memory, initiation, comprehension, perception, and/or psychomotor delay, among other motor function issues. The following conditions may cause cognitive impairment: direct brain tumor effects, surgical resection, medical treatment, weariness, and/or anxiety. Patients with brain tumors find it difficult to focus and pay attention because of this **(Khan et al., 2019)**.

Meanwhile, patients in the study group showed statistically significant improvements in their cognitive function mean scores as measured by the MMSE before discharge, one month after surgery, and at follow-up, when compared to patients in the control group. The rehabilitation program's impact on the patients in the study group may be the cause of this, according to the researchers. While attention was improved in both groups, the study group's attention was significantly improved compared to the control group after they completed the attention and concentration exercises and committed to the early rehabilitation program.

The patients in the study group were able to focus and pay closer attention thanks to all of these strategies. The present study's findings, which indicated that patients with brain tumors had impairment in cognitive function as measured by the MMSE both before and after brain surgery, were corroborated by **Yu et al., (2019**). Additionally, their study's findings showed that patients' cognitive performance, as assessed by the MMSE, significantly improved following brain tumor surgery and rehabilitation.

According to the current study's findings, there was no statistically significant difference in balance impairment between the study and control groups at the preoperative and immediate postoperative stages following a craniotomy or evaluation baseline. According to the same line, **Yu et al., (2019**) study result revealed that patients with brain tumors exhibited impairment in their motor function as well as their balance, as determined by the (BBS) at the time of rehabilitation assessment.

Before discharge, one month after surgery, and two months after surgery, the study group's mean scores for patients' balance, as determined by the Balance Assessment Scale (BBS), were shown to be statistically significantly higher than those of the control group. With the same line, **Kushner & Amidei, (2015)** study indicated that motor dysfunction is frequently observed in patients with primary brain tumors. This condition can result in reduced mobility and ability to do everyday tasks, increased risk of consequences from falls and immobility, anxiety, and/or loss of functional independence.

According to the researchers, this might be because of how the patients in the study group responded to the rehabilitation program. While balance improved in all groups, it was significantly better in the study group—which committed to a rehabilitation program and completed core and balance exercises for brain rehabilitation than in the control group. Using the following techniques to maintain pre-mobilization and socialization, in addition to core and balance exercises, proved beneficial: collaborating with physical therapists and neurosurgeons to develop a mobilization program that the nursing unit would use based on patients' needs and abilities. In addition, patients should be encouraged to communicate while moving and to start mobilizing in and out of bed within 24 to 48 hours of having a craniotomy. They should also be allowed to walk independently as soon as possible. These tactics all assisted the patients in the rehabilitation group in regaining their equilibrium. In a similar vein, **Yu et al., (2019**) study findings documented a noteworthy enhancement in motor function and balance following brain tumor surgery.

The current study's findings demonstrated a highly statistically significant correlation between patients' education and their knowledge levels. This could be because patients that high in education had more accurate knowledge. In the same line, **Gomes et al., (2015**) stated that education level directly influenced patients’ knowledge and behavior regarding the main oral diseases and preventive measures.

The current study's findings demonstrated that there was a highly statistically significant positive correlation between the studied patients' knowledge and practice post-rehabilitation program implementation. This is in line with the findings of **Noman-ul-Haq et al., (2013),** who discovered a positive relationship between knowledge and practice and the idea that having sufficient knowledge might result in a positive outlook and excellent behaviors. The reported positive correlations are explainable by the theory of Reasoned Action. A person’s intention to a specific behavior is a function of their attitude towards that behavior. Furthermore, the attitude toward the behavior is determined by the person’s belief that a given outcome will occur if he/she will perform the behavior **Fisher et al.,(1995).**

The current study's findings revealed the success of the study's aim and its objectivity. The findings of **the Yu et al., (2019)** study, which indicated that pre-rehabilitation is advantageous and required for patients with brain tumors and following brain tumor surgery, corroborated the findings of the current investigation. Following brain tumor surgery, rehabilitation revealed notable short-term gains in motor function, cognitive function, and daily living activities. Most of them expressed satisfaction with gains in daily life activities, motor function, cognitive function, and rehabilitation intensity, and they recommended rehabilitation to other patients. Following a craniotomy, nurses should start rehabilitation as soon as feasible. For individuals with brain tumors, early rehabilitation helps to improve motor function, cognitive function, and general functional independence while preventing problems from immobility **(Kushner & Amidei, 2015)**.

Conclusion:

Based on the results of this study, the present study concluded that the implementation of a rehabilitation program has a significant positive effect on knowledge, practice, balance, and cognitive functions for patients post-craniotomy.

Recommendation:

Based on the results of this study the following recommendations are suggested:

- To enhance patients' knowledge, practice, cognitive and physical abilities following a craniotomy, an ongoing training program is required.

- Following a craniotomy, all patients should participate in a rehabilitation program.

- For patients who have had a craniotomy, comprehensive printed educational materials in plain Arabic, such as booklets, pamphlets, and posters, are needed.

- It is necessary to repeat the current study with a bigger patient sample in various contexts to generalize the findings.

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