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Neurosurgical enhanced recovery after surgery (ERAS) program for elective craniotomies: are patients satisfied with their experiences?
A quantitative and qualitative analysis

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Abstract

Object. The aim of this study was to evaluate the patient satisfaction and associated predictors of patient satisfaction at discharge as well as patient experience at 30-day follow-up in a neurosurgical enhanced recovery after surgery (ERAS) program.

Methods. In a single-center prospective randomized controlled study, 140 neurosurgical patients who were admitted for elective craniotomy were included and randomized into 2 groups: 70 patients received care according to a novel neurosurgical ERAS protocol (ERAS group), and 70 patients received conventional perioperative care (control group). Patient satisfaction at discharge was evaluated using a multi-modal questionnaire. A secondary analysis of patient experience in participating the ERAS program was conducted by a semi-structured qualitative interview via telephone at 30-day follow-up after discharge.

Results. Mean patient satisfaction was significantly higher in the ERAS group compared with control group at discharge (92.2 ± 4.3 vs. 86.8 ± 7.4, P = 0.0001). The most important predictors of patient satisfaction at discharge included age [odds ratio (OR) = 6.934], postoperative nausea and vomiting (PONV) visual analog scale (VAS) (OR = 0.184), absorbable skin suture (OR = 0.007), and postoperative length of stay (LOS) (OR = 0.765). Analysis on patients experience revealed 5 themes: information transfer, professional support, shared responsibility and active participation, readiness for discharge, and follow-up, all of which are closely related and represent positive and negative aspects.

Conclusions. Measures including decreasing PONV VAS, incorporating absorbable skin suture, and shortening LOS seems to increase patient satisfaction in a neurosurgical ERAS program. Analysis of the patient experience data highlights a number of aspects for consideration in achieving patient-centered and high-quality care. Further studies are warranted to standardize the assessment of patient satisfaction and experience in planning, employing and appraising ERAS programs.

Strengths and limitations of this study

- The first study on patient satisfaction and experience in participating a neurosurgical ERAS program.
- A randomized controlled trial to evaluate patient satisfaction.
- Incorporate both quantitative and qualitative analysis.
- Qualitative analysis done solely for ERAS patients.

Introduction

Enhanced recovery after surgery (ERAS) or fast-track surgery program, which was firstly proposed and applied by Kehlet in 1997, has been proven to benefit the patients with shortened hospital length of stay (LOS), improved functional recovery, decreased morbidity and health care costs in several surgical fields including colorectal surgery, urological surgery, orthopedic surgery, cardiac surgery and gynecological surgery.[1-3] Recently, our group had proposed the first neurosurgical ERAS protocol for patients undergoing elective craniotomy and had completed the first randomized controlled trial to evaluate its efficacy and safety.[4] Similar to previous studies, our ERAS program is a multidisciplinary, evidence-based protocol consisting of preoperative, intraoperative, and postoperative interventions as well as a discharge plan. Our results confirmed that implementation of the ERAS program was associated with significant reduction in postoperative LOS and acceleration of functional recovery, without increasing the complication or readmission/reoperation rates compared to conventional neurosurgical perioperative care.[4]

Despite theses known objective benefits of ERAS programs that have been proven repeatedly, very few studies had emphasized the importance of patient satisfaction and experience in participating in such programs.[3 5 6] However, there is now a drive to apprehend the patients' perspective in evaluating quality of health care, which is considered to have equal importance as clinical effectiveness and patients' safety.[3]

Because of the paucity of studies on patient satisfaction and experience associated with the participation in an ERAS program, we have assessed the patient satisfaction at discharge and analyzed the predictive factors of patient satisfaction in elective craniotomy patients who had enrolled in a neurosurgical ERAS program in a

prospective randomized controlled study.

In addition, since patients' perception of comfort is as critical as objective goals of recovery in judging the effectiveness of medical care delivery, we have further incorporated a secondary analysis of patient experience in participating the ERAS program by a semi-structured qualitative interview via telephone at 30-day follow-up after discharge.

Methods

Patient Population

Patients admitted for elective craniotomy at the Department of Neurosurgery of Tangdu Hospital (Xi'an, People's Republic of China) between October 2016 and July 2017 were included in the study of the neurosurgical ERAS program.[4] A total of 140 patients, aged 18 to 65 years-old, who had a single intracranial lesion and medically eligible for elective craniotomy were enrolled and randomly allocated to two groups. The ERAS group received care according to a novel neurosurgical ERAS protocol, which consists of patient evaluation, patient and family counseling, functional status evaluation, nutritional assessment, smoking and alcohol abstinence, antithrombotic prophylaxis, preoperative intestinal intervention, preoperative oral carbohydrate loading, microinvasive surgery, scalp incision anesthesia, nonopioid analgesia, absorbable skin suture, hypothermia avoidance, goal-directed fluid balance, postoperative management of pain and postoperative nausea and vomiting (PONV), early oral nutrition resumption, early ambulation, and so on. The control group received conventional perioperative care according to institutional practice patterns.[4]

Assessment and Data Collection

Demographic variables including age, sex, height, weight, body mass index (BMI), educational level, occupational status, marital status, primary diagnosis of intracranial diseases, American Society of Anesthesiology (ASA) grades and patient comorbidities (smoking, diabetes, hypertension, hypercholesterolemia, etc.) were recorded. Surgery-related variables including length of surgery/anesthesia, blood loss, blood transfusion, and fluid balance were documented as well. Variables associated

with accelerated recovery regimen included PONV visual analogue scales VAS, preoperative carbohydrate loading, absorbable skin suture, mechanical prophylaxis for DVT, early removal of urinary catheter (within 6 h), oral solid intake on postoperative day (POD) 1, mobilization on POD 1, postoperative wound drainage, and pain management. Clinical outcome variables compromised postoperative LOS, total hospital LOS, readmission, reoperation, postoperative surgical and non-surgical complications, functional recovery (i.e. KPS) at discharge and 30-day follow-up.

A modified edition of a validated patient satisfaction questionnaire[7] consisting of 5 modules with 20 questions was applied to assess patient satisfaction at discharge. A cross-sectional pilot study was done to validate the instrument, which showed acceptable internal reliability consistency (Cronbach's alpha exceeded 0.70 for all modules) and test-retest reliability (Weighed Kappa indexes ranged from 0.92 to 0.96, Inter-correlation coefficient ranged from 0.70 to 0.92). The modules incorporated information, medical care, nursing care, enhanced recovery, comfort & others, each of which consists of 4 questions (Additional file 1). Each question was answered using a 1-5 point numerical scale, with higher points indicating higher levels of patient satisfaction: 1 = completely dissatisfied; 2 = moderately dissatisfied, 3= neutral, 4= moderately satisfied, 5= completely satisfied. A scoring scale between 0 and 100 was thus derived from the sum of scores for the individual questions, with 100 indicating the highest level of satisfaction. Educational level, professional status, and marital status were also recorded. An interviewer who was a rotated surgical resident that has not involved in the patient care and blinded to the patient allocation was appointed to fill in all questionnaires.

The secondary assessment at 30-day follow-up after discharge was done via telephone interview. Only patients enrolled in the ERAS program were included in this part of study. Upon discharge an informed consent was obtained from each patient who wanted to participate. A semi-structured interview guide consisting of 6 domains (Additional file 2) was designed to start with a warm-up to greet the patients and assess the 30-day follow-up KPS. Open, broad questions were asked first to encourage the patients to describe their general feelings and experiences about the

ERAS program. A series of questions addressing specific domains including information transfer, symptom management & accelerated recovery, and discharge & follow-up were then asked to determine possible problems and concerns. Finally, cool-down questions were asked to allow patients to add information that has not been discussed. All interviews were recorded and professionally transcribed verbatim for analysis.

Local institutional review board approval was obtained to perform this study and to use archived material for research purposes. The registration number of this study is ChiCTR-INR-16009662, registered at the Chinese clinical trial registry (http://www.chictr.org.cn/showproj.aspx?proj=16480). The protocol adheres to the principles set forth in the US Code of Federal Regulations, Title 45, Part 46, Protection of Human Subjects, revised June 23, 2005, and the World Medical Association Declaration of Helsinki.

Statistical Analysis

To test whether variables differed across groups, the chi-square test or Fisher exact test was used according to the testing condition. Comparisons between continuous data were done using ANOVA (with Scheffe's method for multiple comparisons) or Mann-Whitney U test (with Kruskal-Wallis test for multiple comparisons) according to the testing condition. Multinomial logistic regression was used to identify possible predictors of patient satisfaction. Statistical significance was defined as $p < 0.05$. All of the tests were 2-sided. Statistical analysis was performed using SPSS software (version 16.0, SPSS, Inc.).

Qualitative data analysis of the secondary assessment at 30-day follow-up was done using interpretative phenomenological analysis (IPA) as previously described by Smith et al.[8] Briefly, the transcribed interviews were read and coded individually, and then discussed thoroughly by the research team to identify prominent themes. The process of analysis was done in parallel with the interview so that the developing themes could be tested with reference to new data. Similar themes were then grouped and combined to obtain the final themes. Finally, the themes were interpreted and explained to reveal general issues in common as well as unique features of each

individual regarding patients' experiences.

Patient and public involvement

No patients or members of the public were involved in the development and design of this study. Patients and the general public will be informed of the study results via peer-reviewed journals.

Results

A total of 140 patients enrolled in the study and were randomized into 2 groups: 70 patients were allocated to the ERAS group receiving care according to the neurosurgical ERAS protocol, and 70 patients were allocated to the control group receiving conventional perioperative care. Demographic and clinical features did not significantly differ between the two groups (Table 1). Details of surgery, accelerated recovery regimen, and clinical outcomes were outlined in our previous report.[4] Briefly, there was no significant difference of surgery-related variables between the groups whereas all accelerated recovery regimen-related variables differed significantly between the groups, which were in accordance with the ERAS protocol (Table 2). Additionally, a shorter postoperative LOS (-3d, $P < 0.0001$) was observed in the ERAS group, which was associated with absorbable skin suture, oral solid intake on POD 1, and no postoperative wound drainage in multivariate regression analysis. There was no perioperative mortality, nor 30-day reoperation/readmission in either group. There was no difference of surgical and non-surgical complications rates between the groups. Functional recovery in terms of KPS scores at both discharge and 30-day follow-up were similar in the ERAS vs. control group.[4]

Patient satisfaction at discharge

All patients completed the questionnaire of patient satisfaction at discharge. Mean patient satisfaction in the ERAS group was significantly higher than that in the control group at discharge (92.2 ± 4.3 vs. 86.8 ± 7.4, $P = 0.0001$). Detailed patient satisfaction scores according to each module are shown in Table 3.

A predefined cut-off value of 90 classified the patients into "highly satisfied group" (patient satisfaction score ≥ 90) and "not highly satisfied group" (score < 90). Six

(8.6%) and 37 patients (52.9%) were not highly satisfied in the ERAS and control group, respectively, which were significantly different ($P < 0.0001$).

Univariate analysis including demographic, surgery-related, clinical, and ERAS regimen variables showed significant association between a higher overall patient satisfaction and the following parameters in the ERAS group: mild PONV VAS, absorbable skin suture, and mild pain VAS on POD1 (Supplemental Table 1). ASA grade I, absorbable skin suture, and shorter postoperative LOS (no more than 4 d) were related to higher satisfaction of medical care. Occupational status was correlated with nursing care, with the unemployed expressing higher satisfaction than those were employed and homemaker/student/retired. Mild pain VAS on POD1 also showed more satisfaction with nursing care. Four parameters consisting of PONV VAS, absorbable skin suture, mild pain VAS on POD1, and shorter postoperative LOS, were related to higher satisfaction with enhanced recovery. No variable was found to statistically correlated with satisfaction domains of information or comfort & others. Multivariate logistic regression including variables with $P< 0.20$ in the univariate analysis was done to identify independent predictors of higher overall patient satisfaction. Only ASA grade (β coefficient, 3.602; OR, 36.669; 95% CI, 4.427-303.709; P=0.001) was found to influence patient satisfaction significantly.

On the other side, univariate analysis for the control group revealed ASA grade I as the only parameter associated with a higher overall patient satisfaction (data not shown). Older age (≥50) and lower educational level (with no education or primary education) had a positive correlation with higher satisfaction with information. Factors including ASA grade I and mild PONV VAS were significantly related to higer satisfaction of medical care. ASA grade I was also related to higher satisfaction with nursing care as well as comfort & others. The results of multivariate analysis showed that age (β coefficient, 3.539; OR, 34.428; 95% CI, 2.497-474.715; P=0.008) and ASA grade (β coefficient, -3.454; OR, 0.032; 95% CI, 0.002-0.637; P=0.024) were the independent predictors for overall patient satisfaction.

When combining the two groups together, variables including mild PONV VAS, preoperative carbohydrate loading, absorbable skin suture, mechanical prophylaxis

for DVT, early removal of urinary drainage (within 6 h), oral solid intake on POD1, ambulation on POD1, no postoperative wound drainage, mild pain VAS on POD1, and shorter postoperative LOS all positively influenced overall patient satisfaction in univariate analysis (data not shown). These factors were also correlated with better satisfaction with medical care, nursing care, and enhanced recovery in univariate analysis. Nevertheless, age (β coefficient, 1.936; OR, 6.934; 95% CI, 1.886-25.489; P=0.004), PONV VAS (β coefficient, -1.692; OR, 0.184; 95% CI, 0.036-0.939; P=0.042), absorbable skin suture (β coefficient, -4.984; OR, 0.007; 95% CI, 0.0002-0.281; P=0.009), and postoperative LOS (β coefficient, -3.798; OR, 0.765; 95% CI, 0.185-0.874; P=0.020) were retained as the independent factors affecting patient satisfaction when multivariate analysis was used.

Patient experience at 30-day follow-up

A purposeful sample of 46 patients participated in the semi-structured interviews at 30-day follow-up after discharge. Nineteen men and twenty-seven women aged 18-67 years were interviewed. Of the 46 interviews, two were excluded from analysis because of poor quality of material. Patients' experiences in participating a neurosurgical ERAS program were organized into 5 final themes: information transfer, professional support, shared responsibility and active participation, readiness for discharge, and follow-up.

Information transfer

Most patients felt that they were well educated and counseled when they were enrolled for the ERAS program. However, some reported that too much information was given at the same time so that they were unable to remember everything, nor were they able to think over to raise questions (Table 4- 1). Therefore, it is preferable that the written information was provided one week before surgery.

Professional support

Most patients reported that they acknowledged that it was natural to experience pain/fatigue/nausea associated with surgery and anesthesia, and they were prepared for that in some extent. When they were enrolled for the ERAS program, they expected that the program may help in alleviating these discomfort postoperatively.

Even though the results have proved that more patients in the ERAS group reported mild pain on POD1 and shortened duration of pain than those in the control group,[4] a few patients were dissatisfied with the management of postoperative pain. The different degrees of satisfaction with postoperative pain management could be explained by the subjectivity of pain and individualized experiences of receiving and tolerating analgesia. However the patients mentioned that they did feel better when the caregivers showed great empathy and responded to their complains promptly and actively (Table 4- 2.1). In contrast, they felt worse when some caregivers simply assured them that "it was not uncommon" (Table 4- 2.2). It is valuable for the caregivers to contribute to a positive feeling. Similar issue existed concerning PONV (Table 4- 2.3).

Some patients also reported that the amount of attention they received declined significantly after the first couple of PODs. They felt that some caregivers did not behave patiently enough in listening and responding to their questions and concerns when they have undergone the most intense period postoperatively and seemed "stable" compared to other patients (Table 4- 2.4,2.5).

Shared responsibility and active participation

Though all the patients were excited when they were educated preoperatively that they would be able to drink/eat and ambulate sooner than they expected after surgery, some showed a concern of "being obliged to do so" (Table 4- 3.1). Some felt that the process of accelerated recovery was designed by the caregivers and they were passively striving hard to meet the individual goals preset by the protocol which sometimes ended up with unpleasant experiences (Table 4- 3.2).

In addition, some patients mentioned that they dislike the feeling of being told to follow the "rigid" instructions in their recovery process, instead it would be better if they could play a more active role in setting their own targets from day to day after surgery (Table 4- 3.3).

Readiness for discharge

Many patients expressed their excitement with early discharge, which was also associated with reduced total cost of hospitalization[4] and faster return to normal life

and work. However a few felt that they were not ready to be discharged because a) they were still having mild symptoms (Table 4- 4.1, 4.2); b) they worried that their caretakers might not be able to take care of them at home as good as the caregivers did at the hospital (Table 4- 4.3); c) they felt that it would safer for them to stay in the hospital for a prolonged period of time if any late onset postoperative complications may occur (Table 4- 4.4, 4.5).

Follow-up

All patients praised for the convenience in contacting their primary doctors and relatively prompt response to their questions post discharge in the current study (Table 4- 5). We have been using social media cellphone/website app to contact patient, answer questions, identify possible complications, provide guidance, arrange follow-up visits, and offer support to patients in a timely fashion. This doubtlessly helps patients to alleviate their worry about "being untended" and increase their sense of security upon early discharge.

Discussion

In order to improve health care quality, thorough study of the target population is doubtlessly of great significance to meet the requirements and expectations of individual patients. Patient-oriented outcome measures including functional recovery (e.g. KPS) and patient satisfaction are employed for quality evaluation. We have validated the benefits of a neurosurgical ERAS program in shortening LOS of patients undergoing craniotomy without increasing complication rates.[4] The current study further proved that patients in the ERAS group had higher overall satisfaction as well as higher satisfaction with individual domains including information, medical care, nursing care, and enhanced recovery. Thus, it is possible to provide the patients with satisfactory information, care and treatment during a shortened hospital stay. This highly satisfaction perceived by the patients, which represents patient-based assurance of quality, should be considered as one of the most important end points for any study evaluating the quality of hospital stay associated with the interventions (such as an ERAS program).

Multivariate analysis revealed that higher ASA grade was the only independent predictor of a higher patient satisfaction in the ERAS group, whereas older age and lower ASA grade were independent predictors in the control group. These predictors can be interpreted as determinants of patient satisfaction in each group under circumstances in which most other factors do not vary significantly within each group. It is also understandable that mild PONV VAS, absorbable skin suture, and shorter postoperative LOS, which are among the key distinguishing factors between the two groups, were independent predictors for patient satisfaction in all patients. Age was also a predictor for patient satisfaction in all patients, which is in accordance with previous studies showing that older patients tend to have higher satisfaction scores with hospital health care.[9-11]

Intriguingly, ASA grade was shown to be a significant predictor of patient satisfaction in the ERAS and control group respectively with opposite direction of association; the lower ASA grade, the higher patient satisfaction in control group, whereas the higher ASA grade, the higher patient satisfaction in the ERAS group. In general, patient satisfaction appears to be higher in patients with better self-reported health status as shown in prior studies,[10 11] which is in accordance with the findings in the control group. On the other side, the benefits of the ERAS protocol may account for better satisfaction in patients with higher ASA grade. Satisfaction is a balance between patients' expectations for care and occurrence of care which is actually delivered,[12] and thus reflects changes in health status due to the effectiveness of hospital care. It is possible that for patients with higher ASA grade the ERAS-related interventions have made more profound change in self-perceived health status compared to those with lower ASA grade.

Postoperative LOS was established as an independent predictor for patient satisfaction in all patients in the current study. In addition, it was also related to specific satisfaction domains such as medical care and enhanced recovery in the ERAS group as well as in all patients. The shorter the LOS, the higher the satisfaction, which seems rational and has been shown in other studies as well.[9 11 13]

Bias associated with questionnaire surveys of satisfaction has been recognized as

patients tend to overly positively scored the care they received.[14] Furthermore, patients' explicitly positive attitude toward accelerated discharge actually masks their concerns and complains.[15] Therefore patient experience data may provide with more information in assessing the quality of care to identify the circumstances surrounded the key ERAS components which make the patients satisfactory (or not) as well as the associated reasons.[16]

In the absence of previous relevant study on patient experience in participating a neurosurgical ERAS program, we have conducted a secondary analysis of patient experience at 30-day follow-up after discharge. Based on our results, the 5 different themes were closely related to each other and represent both positive and negative sides. They showed shortcomings of care which warrant improvement in future as well as strong points which may be considered for generalization.

There is no doubt that information transfer the first and foremost step of incorporating patients into an ERAS program. It calls to attention the importance of having the ERAS conversation at least one week before surgery to allow the patients to have enough time to understand the process and raise questions. It was shown that receiving information at appropriate times improved patient satisfaction with their discharge planning.[17 18] This is practical for elective surgeries and should be adopted in future practices.

It is notable that emotional support from healthcare professionals is as crucial as medical interventions in symptom management. When facing dilemmas of burdensome symptoms and expectations for rapid recovery, the patients need to mobilize courage and will to follow the ERAS regimen. Though interventions associated with ERAS protocol have been proved to improve management of postoperative pain and PONV significantly,[4] it is perceived by patients from both previous studies[17 19] and ours that professional's empathy and supportive behavior function as decisive factors in accomplishing objectives of the ERAS program. In addition, as healthcare professionals are often enthusiastic in counseling the patients in the beginning of the study, it is important for them to being responsive to patients' need throughout the hospital stay.

It was overlooked in the practice of current study that the patients need to take responsibilities for their own to achieve an accelerated recovery and good result. They should be encouraged to act more actively and set their own daily goals after surgery. In addition to the shared responsibility and active participation required for the patients,[1 19] they also possess the right to adjust their goals based on their individualized conditions. The supportive role of caregivers should preferably be more like an assistant than a leader to hasten recovery.

It remains a hot and tough issue of patients expressing insecurities about early discharge in several studies on patient experience of ERAS programs. The most common concerns were associated with pain management, mobilization, identifying postoperative complications and lack of family support.[5 15 19 20] Our patients mentioned all these concerns as well. However, our strategy of follow-up with social media cellphone/website app in a timely and responsive manner has proved to be effective in enhancing patients' sense of security and improving their experience after discharge. It is less manpower-relied compared to follow-up visits in person or via phone calls, and benefits the patients significantly. The patients felt that the healthcare providers were still reachable and responsive through the app after discharge. By using the app not only can the medical staffs track and collect follow-up data from the patients, but also can they answer patients' questions, address concerns, guide rehabilitation, identify possible newly onset complications and schedule clinic visits. Therefore patients' traditional beliefs of "safer and necessary prolonged convalescence at hospital" would no longer be a barrier to early discharge in the ERAS program.

One limitation of the current study is that the findings from a single institution with sampled participants can not be automatically generalized. For one thing, sampling bias may exist. For anther, the possible relationship of patients' views and their personal/domestic characteristics were not well studied in the qualitative analysis. Above all things, the views of patients in the control group who received conventional perioperative care were not taken into account in the qualitative analysis either. However, the quantitative analysis which showed higher patient satisfaction with the

ERAS program goes some towards validating the qualitative findings.

Conclusions

Patients in the ERAS group demonstrated higher satisfaction compare with the controls. Factors including age, PONV VAS, absorbable skin suture, and postoperative LOS were independent predictors for overall patient satisfaction. Patients value adequate and consistent information transfer as well as professional support in participating an ERAS program. It is also important to encourage the patients to take active roles and take responsibilities for their own in accelerating recovery. Timely and responsive follow-up modality after discharge could enhance patients' sense of security. The findings of the current study may serve as a stepping stone to promote further research into the evaluation and validation of patient satisfaction and experience in order to improve service delivery and patient care.

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Table 1. Sociodemographic and clinical features

Variable	ERAS group	Control group	p Value
	No. of patients (%)		
No. of patients	70	70	
Age (years)			0.612
<50	33 (47.1)	36 (51.4)	
50-65	37 (52.9)	34 (48.6)	
Sex (Male/Female)	22/48	26/44	0.476
BMI			0.617
<18.5	3 (4.3)	3 (4.3)	
18.5 ~ 23.9	47 (67.1)	52 (74.3)	
>24	20 (28.6)	15 (21.4)	
Education			0.164
No education	4 (5.7)	0 (0)	
Primary school	8 (11.4)	5 (7.1)	
Secondary school/high school	34 (48.6)	39 (55.7)	
College/more than college	24 (34.3)	26 (37.1)	
Occupation			0.352
Employed	29 (41.4)	31 (44.3)	
Homemaker	18 (25.7)	14 (20.0)	
Unemployed	12 (17.1)	19 (27.1)	
Student	3 (4.3)	3 (4.3)	
Retired	8 (11.4)	3 (4.3)	
Marital status			> 0.999
Unmarried (Single/divorced)	5 (7.1)	5 (7.1)	
Married	65 (92.9)	65 (92.9)	
ASA grades			0.410
Grade I	13 (18.6)	17 (24.3)	
Grade II	57 (81.4)	53 (75.7)	
Intracranial lesions			0.779
Meningioma	38 (54.3)	30 (42.9)	
Vestibular Schwanoma	7 (10.0)	9 (12.9)	
CPA epidermoid cyst	6 (8.6)	8 (11.4)	
Glioma	13 (18.6)	18 (25.7)	
Trigeminal neuralgia	3 (4.3)	3 (4.3)	
Cavernous malformation	3 (4.3)	2 (2.9)	

BMI = body mass index, ASA = American Society of Anesthesiologists', CPA = cerebellopontine angle

Table 2. Variables associated with surgery and accelerated recovery regimen

Variable	ERAS group	Control group	p Value
	No. of patients (%)		
No. of patients	70	70	
Length of procedure (hrs)			0.180
<3	15 (21.4)	22 (31.4)	
≥3	55 (78.6)	48 (68.6)	
Blood loss during surgery (ml)			0.310
<300	30 (42.9)	36 (51.4)	
≥300	40 (57.1)	34 (48.6)	
PONV VAS			0.115
Mild (1-4)	60 (85.7)	50 (71.4)	
Moderate (5-6)	7 (10.0)	15 (21.4)	
Severe (7-10)	3 (4.3)	5 (7.1)	
Preoperative carbohydrate loading			<0.0001
Yes	64 (91.4)	0 (0)	
No	6 (8.6)	70 (100.0)	
Absorbable skin suture			<0.0001
Yes	54 (77.1)	0 (0)	
No	16 (22.9)	70 (100.0)	
Mechanical prophylaxis for DVT			<0.0001
Yes	45 (64.3)	11 (15.7)	
No	25 (35.7)	59 (84.3)	
Removal of urinary drainage (hrs)			<0.0001
≤6	52 (74.3)	0 (0)	
>6	18 (25.7)	70 (100.0)	
Time to first oral solid intake (hrs)			<0.0001
≤24	38 (54.3)	12 (17.1)	
>24	32 (45.7)	58 (82.9)	
Ambulation on POD 1			<0.0001
Yes	45 (64.3)	0 (0)	
No	25 (35.7)	70 (100.0)	
Postoperative wound drainage			<0.0001
No	58 (82.9)	2 (2.9)	
Yes	12 (17.1)	68 (97.1)	
Pain VAS on POD1			<0.0001
Mild (1-4)	55 (78.6)	23 (32.9)	
Moderate (5-6)	13 (18.6)	42 (60.0)	
Severe (7-10)	2 (2.9)	5 (7.1)	
Postoperative LOS (d)			<0.0001
≤4	32 (45.7)	7 (10.0)	
>4	38 (54.3)	63 (90.0)	

DVT = deep vein thrombosis, LOS = length of stay, POD = postoperative day, PONV = postoperative nausea and vomiting, VAS = visual analog scale

Table 3. Patient satisfaction scores at discharge

Variable	ERAS group	Control group	p Value
	Median (range)		
Overall Satisfaction	92.2 (85 ~ 100)	86.8 (50 ~ 100)	0.0001
Information	17.4 (15 ~ 20)	16.5 (12 ~ 20)	0.039
Medical care	18.9 (15 ~ 20)	18.3 (15 ~ 20)	0.043
Nursing care	19.2 (17 ~ 20)	18.6 (15 ~20)	0.032
Enhanced recovery	18.5 (15 ~ 20)	15.7 (10 ~20)	< 0.0001
Comfort & others	18.2 (14 ~ 20)	17.9 (12 ~20)	0.317

Table 4. Quotes from patients

Theme	Quotes
1. Information transfer	1.1 “Well you know it’s a good thing but there’s simply too much information out there. So I said to myself ok just let the doctors and nurses tell me what to do next. I’ll follow the instructions as long as I know they mean good.” (#6) 1.2 “They spent quite some time to explain the document point by point. It sounds great. Everybody wants a better outcome. Then they asked me if I had any questions. Well I could not think of any right away. They said I would keep one copy of the documents and I’m welcomed to ask questions at any time. But later on the nurses came for the pre-op stuff, then the barber, then the anesthetist, and the OR nurses. I was preoccupied with the surgery I didn’t even give them a second look. It would be better if they gave me the documents some time earlier rather than only two days before surgery.” (#9)
2. Professional support	2.1 “They gave me a patient-controlled analgesia pump for the first couple of days after surgery and it really helped a lot. I didn’t feel much pain at that time. But things changed the third day when they switched the pump to oral painkillers. It seemed to me that the oral painkillers helped little. I didn’t expect that I’d suffered from surgical pain starting on POD3. Of course I asked for help. Then came this very patient and intellectual nurse. She spent some time to explain to my family and me about the necessity of switching the pump to oral pills. She also told us that the drug used in the pump was the similar type as the oral ones. She mentioned in the end that she could ask the doctors to refill my pump if I really need that. Then I thought well, if I want to go home early I can not rely on the pump. I didn’t refill the pump and the pain did subside as time went by. Also, she checked on me later that day before the shift of duty and the next morning the first thing she came to the ward. I was able to be discharged a couple of days later, going home with oral painkillers. I was very thankful to her.” (#29) 2.2 “I knew it was natural to had pain because of the surgery but it was intense. I expected the doctor to do something but he just told me ‘It is not uncommon. If I were you I’d have the pain too.’ It was not helping.” (#26) 2.3 “The smell of food made me really nausea and I didn't want to eat at all. I called the nurse and then she called in a doctor. He checked my order of drugs and said they already give me drugs for the nausea and it was natural because there’s certainly some swelling in my brain due to the surgery.” (#5)

	2.4 “It felt like that they really wanted me to join the program and they really wanted to make sure that I met the milestones. Removal of urinary drain, oral liquid and then solid food intake, off-bed activity… I thought I did everything great. I was proud of myself and grateful to the healthcare team. But after that I felt like I was abandoned. They were probably busy helping others who were not doing great as I did…” (#40) 2.5 “In the beginning when the nurses had their shifts in front of my bed they would remind each other ‘this is an ERAS patient’ and I know it means something different. I can tell that they paid more attention to me than to other patients... Later on they were talking like ‘this is an ERAS patient and he already got off bed yesterday’ Then I became the one who doesn't deserve their attention.” (#13)
3. Shared responsibility and active participation	3.1 “You signed the consent and you made a commitment. You are obliged to stay strong and comply with the rules. It is a sort of pressure.” (#40) 3.2 “The second afternoon after I had my surgery the nurse came in to remind me that it was time for me to get off bed and try to walk according to the schedule. Yes I could fetch my meals and they had removed the drip. But I was not feeling well enough. I had some faintness. I asked ‘maybe we can try tomorrow morning?’ but she kept telling me that how other managed to walk on the second day after surgery and that ‘nobody was ready enough for that’. I didn’t want to annoy her so I tried. I could not recall what happened next because I passed out. She was scared of course. She came to apologize to me the next day. I don’t blame her personally but they should have a mechanism to adjust the goal and not to take them as fixed rules.” (#25) 3.3 “A nurse came in and she shouted ‘how come you’re still in bed? You don’t have any IV fluids today and now try to walk’. But I already walked and I even walked two rounds in the corridor earlier that morning. She did not come early enough to see that… I’m not a soldier to follow the rigid instructions as when to do what.” (#15)
4. Readiness for discharge	4.1 “When he [resident] reported to the senior doctor that ‘she’s going to be discharged today’ I thought what’s going on, he must be insane. I was not well enough. I’m stilling having this right facial paralysis. I still can’t close my right eye tightly” (#20) 4.2 “I was happy to go home only 3 days after surgery, but I wasn’t totally pain free at that time. I couldn’t help thinking maybe I should stay for another couple of days and then go home in a better condition?” (#9)

5. Follow-up	4.3 “Here in the hospital my son and daughter are around. They are using their annual leave for my hospitalization. But once I go home they’ll have their own family and children to look after… They live quite far away… My husband, he has never done any housework at home. If I don’t cook, he will starve. How can you expect him to take care of me?” (#7) 4.4 “My daughter really devoted herself to helping me recover from the surgery and I know that she wanted me home. But she is not a nurse anyway. I simply believe that it is safer to stay in the hospital. You are surrounded by medical staff so if there’s anything going wrong they will find it out and deal with it quickly.” (#23) 4.5 “I don’t trust the community hospitals and I will certainly go back to the hospital where I had my surgery if anything is wrong. I’m not living close to the hospital. And I know that it’s a busy center and there is a huge number of patients to be admitted. What if they can’t guarantee a bed if I need readmission?” (#40) 5.1 “This cell phone app works way much better than phone calls. I never called the ward even though I had the number. You nerve know whether the people answers the phone really know whom you are. But it is the doctor who did my surgery and took care of me that is now interacting with me on this app. He knows my condition.” (#20) 5.2 “I know that the doctors are always busy doing the surgeries and dealing with new patients so you don’t want to bother them in the middle of their work. I just left a message to my doctor and whenever he got time he would reply or call back. In this way my questions are answered and I don’t feel myself as a burden to him.” (#9) 5.3 “The third day after I went home I had a funny feeling around the wound. There was a small lump next to the wound which felt soft. My son took a picture of that with his cell phone and sent it to the doctors. They called me to go to the clinic. It turned out that I developed some water under the scalp and they fixed it easily. That was unimaginably convenient.” (#21)

Supplemental Table 1. Univariate analysis for predictors of satisfaction in the ERAS group

Variable	Patient satisfaction											
	Overall Satisfaction		Information		Medical care		Nursing care		Enhanced recovery		Comfort & others	
	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value
Age (yrs)		0.332		0.070		0.915		0.784		0.852		0.650
<50	91.6 (89.7 ~ 93.5)		16.9 (16.1 ~ 17.6)		19.0 (18.5 ~ 19.4)		19.1 (18.7 ~ 19.5)		18.5 (17.7 ~ 19.2)		18.1 (17.5 ~ 18.8)	
≥50	92.8 (91.0 ~ 94.7)		17.8 (17.1 ~ 18.5)		18.9 (18.3 ~ 19.5)		19.2 (18.8 ~ 19.6)		18.5 (17.9 ~ 19.2)		18.3 (17.7 ~ 18.9)	
Sex		0.770		0.865		0.614		0.522		0.757		0.639
Male	92.5 (89.6 ~ 95.4)		17.5 (16.2 ~ 18.7)		19.1 (18.4 ~ 19.8)		19.3 (18.7 ~ 19.9)		18.6 (17.7 ~ 19.6)		18.1 (17.0 ~ 19.1)	
Female	92.1 (90.7 ~ 93.6)		17.4 (16.8 ~ 17.9)		18.9 (18.5 ~ 19.3)		19.1 (18.8 ~ 19.4)		18.5 (17.9 ~ 19.0)		18.3 (17.8 ~ 18.8)	
Education		0.795		0.525		0.142		0.864		0.623		0.187
No education/Primary	91.9 (87.4 ~ 96.3)		17.8 (16.2 ~ 19.4)		18.4 (17.0 ~ 19.8)		19.1 (18.6 ~ 19.7)		18.3 (17.4 ~ 19.4)		18.4 (17.4 ~ 19.4)	
Secondary/College	92.3 (91.0 ~ 93.7)		17.3 (16.8 ~17.9)		19.1 (18.7 ~ 19.4)		19.2 (18.9 ~ 19.5)		18.2 (17.7 ~ 18.7)		18.2 (17.7 ~ 18.7)	
Occupation		0.280		0.624		0.105		0.019		0.955		0.485
Employed	92.9 (90.9 ~ 94.9)		17.4 (16.6 ~ 18.3)		19.4 (19.0 ~ 19.8)		19.3 (18.9 ~ 19.7)		18.4 (17.6 ~ 19.2)		18.4 (17.6 ~19.1)	
Unemployed	93.5 (89.2 ~ 97.8)		17.9 (16.2 ~ 19.6)		18.8 (17.6 ~ 19.9)		19.8 (19.4 ~ 20.1)		18.5 (17.0 ~ 20.0)		18.6 (17.5 ~ 19.7)	

Homemaker/ Student/Retired	91.0 (91.0 ~ 93.5)		17.2 (16.4 ~ 17.9)		18.6 (18.0 ~ 19.2)		18.9 (18.4 ~ 19.2)		18.6 (17.9 ~ 19.3)		18.0 (17.3 ~ 18.6)	
Marital status		0.653		0.779		0.689		0.305		0.183		0.602
Unmarried (Single/divorced)	93.3 (79.0 ~ 107.7)		17.7 (11.4 ~ 23.9)		18.7 (15.8 ~ 21.5)		18.7 (14.9 ~ 22.5)		19.7 (18.2 ~ 21.1)		18.7 (14.9 ~ 22.5)	
Married	92.2 (90.9 ~ 93.5)		17.4 (16.9 ~ 17.9)		19.0 (18.6 ~ 19.3)		19.2 (19.0 ~ 19.5)		18.4 (17.9 ~ 18.9)		18.2 (17.8 ~ 18.7)	
ASA grades		0.124		0.611		0.004		0.119		0.851		0.595
Grade I	90.3 (88.3 ~ 92.4)		17.1 (15.9 ~ 18.3)		17.9 (16.8 ~ 18.9)		18.8 (18.0 ~ 19.5)		18.4 (17.1 ~ 19.8)		18.1 (17.5 ~ 18.7)	
Grade II	92.8 (91.2 ~ 94.4)		17.4 (16.8 ~ 18.1)		19.1 (18.8 ~ 19.5)		19.3 (19.0 ~ 19.6)		18.6 (18.0 ~ 19.1)		18.4 (17.9 ~ 18.9)	
Length of procedure (hrs)		0.493		0.738		0.384		0.195		0.313		0.903
<3	91.0 (86.8 ~ 95.2)		17.5 (16.0 ~ 19.0)		18.5 (17.2 ~ 19.8)		18.8 (17.9 ~ 19.6)		18.0 (16.2 ~ 19.8)		18.3 (17.3 ~ 19.2)	
≥3	92.2 (90.7 ~ 93.7)		17.3 (16.6 ~ 17.9)		18.9 (18.5 ~ 19.3)		19.2 (18.9 ~ 19.5)		18.6 (18.1 ~ 19.2)		18.2 (17.6 ~ 18.7)	
Blood loss during surgery (ml)		0.973		0.564		0.496		0.054		0.685		0.693
<300	92.3 (90.0 ~ 94.6)		17.6 (16.7 ~ 18.5)		18.8 (18.2 ~ 19.4)		19.0 (18.5 ~ 19.4)		18.6 (17.8 ~ 19.4)		18.4 (17.8 ~ 19.0)	
≥300	92.3 (90.7 ~ 94.0)		17.3 (16.6 ~ 18.0)		19.0 (18.6 ~19.5)		19.4 (19.1 ~ 19.7)		18.4 (17.8 ~ 19.0)		18.2 (17.6 ~18.8)	

PONV VAS		0.036		0.359		0.142		0.134		0.011		0.809
Mild (1-4)	92.8 (91.5 ~ 94.1)		17.5 (16.9 ~ 18.1)		19.1 (18.7 ~ 19.4)		19.3 (19.0 ~ 19.5)		18.8 (18.4 ~ 19.2)		18.3 (17.8 ~ 18.7)	
Moderate (5-6)/Severe (7-10)	89.4 (85.3 ~ 93.5)		16.9 (15.2 ~ 18.5)		18.4 (17.0 ~ 19.8)		18.8 (17.8 ~ 19.7)		17.3 (15.2 ~ 19.3)		18.1 (16.9 ~ 19.3)	
Preoperative carbohydrate loading		0.684		0.446		0.853		0.196		0.363		0.516
Yes	92.1 (90.8 ~ 93.5)		17.3 (16.8 ~17.9)		19.0 (18.6 ~19.3)		19.1 (18.8 ~ 19.4)		18.6 (18.1 ~ 19.1)		18.2 (17.7 ~18.7)	
No	92.9 (88.3 ~ 97.4)		17.9 (16.4 ~ 19.3)		18.9 (17.5 ~ 20.2)		19.6 (19.1 ~ 20.1)		18.0 (16.3 ~ 19.7)		18.6 (17.4 ~19.8)	
Absorbable skin suture		0.071		0.977		0.004		0.543		0.011		0.982
Yes	92.8 (91.4 ~ 94.2)		17.4 (16.8 ~18.0)		19.2 (18.8 ~ 19.5)		19.2 (18.9 ~ 19.5)		18.8 (18.3 ~ 19.2)		18.3 (17.7 ~ 18.8)	
No	89.8 (86.9 ~ 92.6)		17.4 (15.9 ~ 18.9)		17.9 (16.6 ~ 19.2)		19.0 (18.4 ~ 19.6)		17.3 (15.8 ~ 18.7)		18.3 (17.7 ~ 18.8)	
Mechanical prophylaxis for DVT		0.724		0.695		0.553		0.787		0.422		0.693
Yes	92.3 (90.6 ~ 94.0)		17.4 (16.7 ~18.1)		19.0 (18.6 ~ 19.4)		19.2 (18.9 ~ 19.6)		18.4 (17.8 ~ 19.0)		18.3 (17.7 ~ 18.9)	
No	92.8 (90.7 ~ 94.9)		17.6 (16.7 ~ 18.5)		18.8 (18.1 ~ 19.5)		19.2 (18.7 ~ 19.6)		18.8 (18.0 ~ 19.5)		18.4 (17.9 ~ 19.0)	

Removal of urinary drainage (hrs)		0.421	0.298	0.777	0.240	0.816	0.664
≤6	91.9 (90.5 ~93.4)	17.2 (16.6 ~ 17.8)	19.0 (18.5 ~ 19.4)	19.1 (18.8 ~ 19.4)	18.5 (17.9 ~ 19.0)	18.2 (17.7 ~ 18.8)	
>6	93.1 (90.2 ~ 96.0)	17.8 (16.7 ~ 18.9)	18.9 (18.3 ~ 19.5)	19.4 (19.1 ~ 19.8)	18.6 (17.7 ~ 19.5)	18.4 (17.7 ~ 19.1)	
Time to first oral solid intake (hrs)		0.947	0.709	0.559	0.434	0.399	0.549
≤24	92.2 (90.4 ~ 94.0)	17.5 (16.8 ~ 18.2)	18.8 (18.3 ~ 19.4)	19.1 (18.7 ~ 19.5)	18.7 (18.1 ~ 19.3)	18.1 (17.5 ~ 18.7)	
>24	92.3 (90.3 ~ 94.3)	17.3 (16.4 ~ 18.1)	19.1 (18.6 ~19.5)	19.3 (18.9 ~ 19.6)	18.3 (17.5 ~ 19.1)	18.4 (17.7 ~ 19.0)	
Ambulation on POD 1		0.996	0.774	0.821	0.483	0.630	0.542
Yes	92.2 (90.6 ~ 93.9)	17.5 (16.8 ~ 18.1)	19.0 (18.5 ~ 19.5)	19.1 (18.7 ~ 19.5)	18.6 (18.0 ~ 19.2)	18.1 (17.6 ~ 18.7)	
No	92.2 (90.0 ~ 94.5)	17.3 (16.4 ~ 18.2)	18.9 (18.3 ~ 19.4)	19.3 (19.0 ~ 19.6)	18.4 (17.5 ~ 19.2)	18.4 (17.7 ~ 19.1)	
Postoperative wound drainage		0.246	0.977	0.142	0.864	0.081	0.809
No	92.6 (91.2 ~ 94.0)	17.4 (16.8 ~ 18.0)	19.1 (18.7 ~ 19.4)	19.2 (18.9 ~ 19.5)	18.7 (18.2 ~ 19.2)	18.3 (17.8 ~ 18.8)	
Yes	90.6 (87.1 ~ 94.1)	17.4 (16.0 ~ 18.7)	18.4 (17.5 ~ 19.3)	19.1 (18.6 ~ 19.7)	17.6 (16.4 ~ 18.9)	18.1 (17.2 ~ 19.1)	

Pain VAS on POD1		0.006	0.853	0.054	0.001	0.020	0.067
Mild (1-4)	93.1 (91.7 ~ 94.5)	17.4 (16.8 ~18.0)	19.1 (18.8 ~19.5)	19.4 (19.1 ~ 19.7)	18.8 (18.3 ~ 19.3)	18.4 (18.0 ~18.9)	
Moderate (5-6)/Severe (7-10)	89.0 (86.7 ~ 91.3)	17.3 (16.3 ~ 18.3)	18.3 (17.2 ~ 19.4)	18.4 (18.0 ~ 18.8)	17.5 (16.3 ~ 18.7)	17.5 (16.4 ~ 18.6)	
Postoperative LOS (d)		0.219	0.971	0.017	0.829	0.045	0.837
≤4	93.1 (91.0 ~ 95.2)	17.4 (16.6 ~ 18.2)	19.4 (19.0 ~ 19.8)	19.2 (18.7 ~ 19.6)	19.0 (18.4 ~ 19.6)	18.2 (17.4 ~ 19.0)	
>4	91.5 (90.0 ~ 93.2)	17.4 (16.7 ~ 18.1)	18.6 (18.0 ~ 19.1)	19.2 (18.9 ~ 19.5)	18.1 (17.4 ~ 18.8)	18.3 (17.8 ~ 18.8)	

ASA = American Society of Anesthesiologists', DVT = deep vein thrombosis, LOS = length of stay, POD = postoperative day, PONV = postoperative nausea and vomiting, VAS = visual analog scale

Additional file 1 Summary of the questions included in the patient satisfaction questionnaire at discharge.

Module 1- Information
- Information delivery
- Patient counseling
- Doctors' and nurses' interest in patients' questions
- Contradictory orders

Module 2- Medical care
- Experience of operation
- Doctors' rounds
- Postoperative symptom management
- Explanations about health condition & treatment

Module 3- Nursing care
- Preoperative preparation
- Postoperative nursing care
- Nurses' empathy
- Response to patient/family need

Module 4- Enhanced recovery
- Nutritional intervention
- Functional recovery assistance
- Discharging criteria & follow-up arrangement
- Outcome of surgery/hospitalization

Module 5- Comfort & others
- Environmental conditions
- Sense of security
- Cost
- Administration & logistics

Additional file 2 Semi-structured interview guide at 30-day follow-up after discharge.

Warm up

- Self introduction
- Thank patient for participating and confirm consent verbally
- Assess 30-day follow-up KPS

General questions

- How did you feel about the recent hospital stay and the ERAS program?
- What concerns you most about the ERAS program?
- What do you recall in participating the ERAS program?

Information transfer

- How did you feel about the education and counseling when you were enrolled for the ERAS program?
- Do you recall any differences between the written information and verbal information?
- Did the doctors' and nurses' respond to your questions and concerns adequately?

Symptom management & accelerated recovery

- What were your expectations about pain/fatigue/nausea and vomiting after surgery?
- Was symptom control better/worse than you expected?
- How was your recovery process after surgery? Was it faster/slower than you expected? Was it harder/easier than you expected?

Discharge & follow-up

- How did you feel about the time and condition at discharge? Did you feel ready to be discharged? Did you have any concern about early discharge?
- Did you have any discomfort or problem after discharge? Did you get any help/guidance from the primary doctors?
- How was your family support after discharge?

Cool down

- Encourage patient to talk about their experience/concerns/suggestions not mentioned in the previous questions

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Neurosurgical enhanced recovery after surgery (ERAS) program for elective craniotomies: are patients satisfied with their experiences?

A quantitative and qualitative analysis

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Abstract

Objectives. To evaluate the patient satisfaction and associated predictors at discharge as well as patient experience at 30-day follow-up in a neurosurgical enhanced recovery after surgery (ERAS) program.

Design. A single-center prospective randomized controlled study.

Setting. A tertiary hospital in China.

Participants. A total of 140 neurosurgical patients admitted for elective craniotomy between October 2016 and July 2017 were included if they aged 18-65 years-old and had a single intracranial lesion.

Interventions. Patients were randomized into 2 groups: 70 patients received care according to a novel neurosurgical ERAS protocol (ERAS group), and 70 patients received conventional perioperative care (control group).

Outcome measures. Patient satisfaction at discharge was evaluated using a multi-modal questionnaire. A secondary analysis of patient experience in participating the ERAS program was conducted by a semi-structured qualitative interview via telephone at 30-day follow-up.

Results. Mean patient satisfaction was significantly higher in ERAS group than control group at discharge (92.2 ± 4.3 vs. 86.8 ± 7.4, P = 0.0001). The most important predictors of patient satisfaction included age [odds ratio (OR) = 6.934], postoperative nausea and vomiting (PONV) visual analog scale (VAS) (OR = 0.184), absorbable skin suture (OR = 0.007), and postoperative length of stay (LOS) (OR = 0.765). Analysis on patients experience revealed 5 themes: information transfer, professional support, shared responsibility and active participation, readiness for discharge, and follow-up, all of which are closely related and represent positive and negative aspects.

Conclusions. Measures including decreasing PONV VAS, incorporating absorbable skin suture, and shortening LOS seem to increase patient satisfaction in a neurosurgical ERAS program. Analysis of patient experience data highlights several aspects to achieve patient-centered and high-quality care. Further studies are warranted to standardize the assessment of patient satisfaction and experience in

planning, employing and appraising ERAS programs.

Trial registration. Chinese Clinical Trial Registry (http://www.chictr.org.cn/showproj.aspx?proj=16480), ChiCTR-INR-16009662.

Strengths and limitations of this study

- A randomized controlled trial to evaluate patient satisfaction.
- Incorporate both quantitative and qualitative analysis.
- Qualitative analysis done solely for ERAS patients without controls.

Introduction

Enhanced recovery after surgery (ERAS) or fast-track surgery program, which was firstly proposed and applied by Kehlet in 1997, has been proven to benefit the patients with shortened hospital length of stay (LOS), improved functional recovery, decreased morbidity and health care costs in several surgical fields including colorectal surgery, urological surgery, orthopedic surgery, cardiac surgery and gynecological surgery.[1-3] Recently, our group had proposed the first neurosurgical ERAS protocol for patients undergoing elective craniotomy and had completed the first randomized controlled trial to evaluate its efficacy and safety.[4] Similar to previous studies, our ERAS program is a multidisciplinary, evidence-based protocol consisting of preoperative, intraoperative, and postoperative interventions as well as a discharge plan. Our results confirmed that implementation of the ERAS program was associated with significant reduction in postoperative LOS and acceleration of functional recovery, without increasing the complication or readmission/reoperation rates compared to conventional neurosurgical perioperative care.[4]

Despite theses known objective benefits of ERAS programs that have been proven repeatedly, very few studies had emphasized the importance of patient satisfaction and experience in participating in such programs.[3 5 6] However, there is now a drive to apprehend the patients' perspective in evaluating quality of health care, which is considered to have equal importance as clinical effectiveness and patients' safety.[3]

Because of the paucity of studies on patient satisfaction and experience associated with the participation in an ERAS program, we have assessed the patient satisfaction at discharge and analyzed the predictive factors of patient satisfaction in elective craniotomy patients who had enrolled in a neurosurgical ERAS program in a prospective randomized controlled study.

In addition, since patients' perception of comfort is as critical as objective goals of recovery in judging the effectiveness of medical care delivery, we have further incorporated a secondary analysis of patient experience in participating the ERAS program by a semi-structured qualitative interview via telephone at 30-day follow-up after discharge.

Methods

Patient Population

Patients admitted for elective craniotomy at the Department of Neurosurgery of Tangdu Hospital (Xi'an, People's Republic of China) between October 2016 and July 2017 were included in the study of the neurosurgical ERAS program.[4] A total of 140 patients, aged 18 to 65 years-old, who had a single intracranial lesion and medically eligible for elective craniotomy were enrolled and randomly allocated to two groups. The ERAS group received care according to a novel neurosurgical ERAS protocol, which consists of patient evaluation, patient and family counseling, functional status evaluation, nutritional assessment, smoking and alcohol abstinence, antithrombotic prophylaxis, preoperative intestinal intervention, preoperative oral carbohydrate loading, microinvasive surgery, scalp incision anesthesia, nonopioid analgesia, absorbable skin suture, hypothermia avoidance, goal-directed fluid balance, postoperative management of pain and postoperative nausea and vomiting (PONV), early oral nutrition resumption, early ambulation, and so on. The control group received conventional perioperative care according to institutional practice patterns.[4]

Assessment and Data Collection

Demographic variables including age, sex, height, weight, body mass index (BMI), educational level, occupational status, marital status, primary diagnosis of intracranial

diseases, American Society of Anesthesiology (ASA) grades and patient comorbidities (smoking, diabetes, hypertension, hypercholesterolemia, etc.) were recorded. Surgery-related variables including length of surgery/anesthesia, blood loss, blood transfusion, and fluid balance were documented as well. Variables associated with accelerated recovery regimen included PONV visual analogue scales VAS, preoperative carbohydrate loading, absorbable skin suture, mechanical prophylaxis for DVT, early removal of urinary catheter (within 6 h), oral solid intake on postoperative day (POD) 1, mobilization on POD 1, postoperative wound drainage, and pain management. Clinical outcome variables compromised postoperative LOS, total hospital LOS, readmission, reoperation, postoperative surgical and non-surgical complications, functional recovery (i.e. KPS) at discharge and 30-day follow-up.

A modified edition of a validated patient satisfaction questionnaire consisting of 5 modules with 20 questions was applied to assess patient satisfaction at discharge.[7] A cross-sectional pilot study was done to validate the instrument, which showed acceptable internal reliability consistency (Cronbach's alpha exceeded 0.70 for all modules) and test-retest reliability (Weighed Kappa indexes ranged from 0.92 to 0.96, Inter-correlation coefficient ranged from 0.70 to 0.92). The modules incorporated information, medical care, nursing care, enhanced recovery, comfort & others, each of which consists of 4 questions (Additional file 1). Each question was answered using a 1-5 point numerical scale, with higher points indicating higher levels of patient satisfaction: 1 = completely dissatisfied; 2 = moderately dissatisfied, 3= neutral, 4= moderately satisfied, 5= completely satisfied. A scoring scale between 0 and 100 was thus derived from the sum of scores for the individual questions, with 100 indicating the highest level of satisfaction. Educational level, professional status, and marital status were also recorded. An interviewer who was a rotated surgical resident that has not involved in the patient care and blinded to the patient allocation was appointed to fill in all questionnaires.

The secondary assessment at 30-day follow-up after discharge was done via telephone interview. Only patients enrolled in the ERAS program were included in this part of study. Upon discharge an informed consent was obtained from each patient who

wanted to participate. Maximum variation sampling was applied to form a purposive sample of 46 participants. In order to obtain and analyze patient experience in participating the ERAS program, an interpretative phenomenological approach was used.[8] Interviews were conducted by doctors from the Department of Neurosurgery (BL, YW, YZ, TZ, YX. LC, YW) employing a rule of not interviewing his/her own patients during hospital care. Participants were approached via telephone at home, with some having their family members present during the interview. A semi-structured interview guide consisting of 6 domains (Additional file 2) was designed to start with a warm-up to greet the patients and assess the 30-day follow-up KPS. Open, broad questions were asked first to encourage the patients to describe their general feelings and experiences about the ERAS program. A series of questions addressing specific domains including information transfer, symptom management & accelerated recovery, and discharge & follow-up were then asked to determine possible problems and concerns. Finally, cool-down questions were asked to allow patients to add information that has not been discussed. All interviews were audio-recorded and professionally transcribed verbatim immediately after the interview for analysis. No patient refused to participate or dropped out. The recruitment of additional patients stopped when data analysis would not be changed with more interviews, which is a convention of qualitative studies.

Compliance With Ethical Standards

Local institutional review board (IRB) approval was obtained to perform this study and to use archived material for research purposes. The trial was prospectively registered at the Chinese clinical trial registry (http://www.chictr.org.cn/showproj.aspx?proj=16480) with registration number ChiCTR-INR-16009662 on 27 October 2016. The first patient was enrolled on 30 October 2016. The protocol adheres to the principles set forth in the US Code of Federal Regulations, Title 45, Part 46, Protection of Human Subjects, revised June 23, 2005, and the World Medical Association Declaration of Helsinki.

Patient satisfaction at discharge was one of the secondary endpoints included in the original study protocol approved by the IRB.[4] For the purpose of constant quality

improvement, the ERAS protocol has been continually applied and refined based on feedbacks from the patients and providers as well as updates in the related fields. Qualitative interview on patient experience at 30-day follow-up was additionally included in the study and was further approved by the IRB.

Statistical Analysis

To test whether variables differed across groups, the chi-square test or Fisher exact test was used according to the testing condition. Comparisons between continuous data were done using ANOVA (with Scheffe's method for multiple comparisons) or Mann-Whitney U test (with Kruskal-Wallis test for multiple comparisons) according to the testing condition. Multinomial logistic regression was used to identify possible predictors of patient satisfaction. Statistical significance was defined as $p < 0.05$. All of the tests were 2-sided. Statistical analysis was performed using SPSS software (version 16.0, SPSS, Inc.).

As part of a randomized controlled study evaluating the safety and efficacy of a neurosurgical ERAS program, patient satisfaction at discharge was assessed as a secondary outcome.[4] The sample size was powered to be 58 patients in each group based on the hypothesis that the primary outcome (i.e. postoperative LOS) would be reduced by 25% (from about 7 days to 5 days) with a power of 80% and a significance of 5%. Assuming a maximal dropout rate of 20%, the final sample size was determined as 70 patients per arm.[4]

Qualitative data analysis of the secondary assessment at 30-day follow-up was done using interpretative phenomenological analysis (IPA) as previously described by Smith et al.[8] Briefly, each transcribed interview was read and coded by 3 researchers independently (BL, SL, YW), and then discussed thoroughly by the research team to identify prominent themes. The process of analysis was done in parallel with the interview so that the developing themes could be tested with reference to new data. Similar themes were then grouped and combined to obtain the final themes. Finally, the themes were interpreted and explained to reveal general issues in common as well as unique features of each individual regarding patients' experiences. A subgroup of participants were approached later during their follow-up at the hospital outpatient

clinic to provide feedback on the findings of the researchers.

Patient and public involvement

No patients or members of the public were involved in the development and design of this study. Patients and the general public will be informed of the study results via peer-reviewed journals.

Results

A total of 140 patients enrolled in the study and were randomized into 2 groups: 70 patients were allocated to the ERAS group receiving care according to the neurosurgical ERAS protocol, and 70 patients were allocated to the control group receiving conventional perioperative care. Demographic and clinical features did not significantly differ between the two groups (Table 1). Details of surgery, accelerated recovery regimen, and clinical outcomes were outlined in our previous report.[4] Briefly, there was no significant difference of surgery-related variables between the groups whereas all accelerated recovery regimen-related variables differed significantly between the groups, which were in accordance with the ERAS protocol (Table 2). Additionally, a shorter postoperative LOS (-3d, $P < 0.0001$) was observed in the ERAS group, which was associated with absorbable skin suture, oral solid intake on POD 1, and no postoperative wound drainage in multivariate regression analysis. There was no perioperative mortality, nor 30-day reoperation/readmission in either group. There was no difference of surgical and non-surgical complications rates between the groups. Functional recovery in terms of KPS scores at both discharge and 30-day follow-up were similar in the ERAS vs. control group.[4]

Patient satisfaction at discharge

All patients completed the questionnaire of patient satisfaction at discharge. Mean patient satisfaction in the ERAS group was significantly higher than that in the control group at discharge (92.2 ± 4.3 vs. 86.8 ± 7.4, $P = 0.0001$). Detailed patient satisfaction scores according to each module are shown in Table 3.

A predefined cut-off value of 90 classified the patients into "highly satisfied group" (patient satisfaction score ≥ 90) and "not highly satisfied group" (score < 90). Six

(8.6%) and 37 patients (52.9%) were not highly satisfied in the ERAS and control group, respectively, which were significantly different ($P < 0.0001$).

Univariate analysis including demographic, surgery-related, clinical, and ERAS regimen variables showed significant association between a higher overall patient satisfaction and the following parameters in the ERAS group: mild PONV VAS, absorbable skin suture, and mild pain VAS on POD1 (Supplemental Table 1). ASA grade I, absorbable skin suture, and shorter postoperative LOS (no more than 4 d) were related to higher satisfaction of medical care. Occupational status was correlated with nursing care, with the unemployed expressing higher satisfaction than those were employed and homemaker/student/retired. Mild pain VAS on POD1 also showed more satisfaction with nursing care. Four parameters consisting of PONV VAS, absorbable skin suture, mild pain VAS on POD1, and shorter postoperative LOS, were related to higher satisfaction with enhanced recovery. No variable was found to statistically correlated with satisfaction domains of information or comfort & others. Multivariate logistic regression including variables with $P< 0.20$ in the univariate analysis was done to identify independent predictors of higher overall patient satisfaction. Only ASA grade (β coefficient, 3.6; OR, 36.7; 95% CI, 4.4-303.7; $P=0.001$) was found to influence patient satisfaction significantly.

On the other side, univariate analysis for the control group revealed ASA grade I as the only parameter associated with a higher overall patient satisfaction (data not shown). Older age (≥50) and lower educational level (with no education or primary education) had a positive correlation with higher satisfaction with information. Factors including ASA grade I and mild PONV VAS were significantly related to higer satisfaction of medical care. ASA grade I was also related to higher satisfaction with nursing care as well as comfort & others. The results of multivariate analysis showed that age (β coefficient, 3.5; OR, 34.4; 95% CI, 2.5-474.7; $P=0.008$) and ASA grade (β coefficient, -3.5; OR, 0.03; 95% CI, 0.002-0.6; $P=0.024$) were the independent predictors for overall patient satisfaction.

When combining the two groups together, variables including mild PONV VAS, preoperative carbohydrate loading, absorbable skin suture, mechanical prophylaxis

for DVT, early removal of urinary drainage (within 6 h), oral solid intake on POD1, ambulation on POD1, no postoperative wound drainage, mild pain VAS on POD1, and shorter postoperative LOS all positively influenced overall patient satisfaction in univariate analysis (data not shown). These factors were also correlated with better satisfaction with medical care, nursing care, and enhanced recovery in univariate analysis. Nevertheless, age (β coefficient, 1.9; OR, 6.9; 95% CI, 1.9-25.5; P=0.004), PONV VAS (β coefficient, -1.7; OR, 0.2; 95% CI, 0.04-0.9; P=0.042), absorbable skin suture (β coefficient, -5.0; OR, 0.007; 95% CI, 0.0002-0.3; P=0.009), and postoperative LOS (β coefficient, -3.8; OR, 0.8; 95% CI, 0.2-0.9; P=0.020) were retained as the independent factors affecting patient satisfaction when multivariate analysis was used.

Patient experience at 30-day follow-up

A purposeful sample of 46 patients participated in the semi-structured interviews at 30-day follow-up after discharge. A total of 19 men and 27 women aged 18-65 years were interviewed. The duration of interviews ranged 15-30 minutes. Of the 46 interviews, two were excluded from analysis because of poor quality of material. Patients' experiences in participating a neurosurgical ERAS program were organized into 5 final themes: information transfer, professional support, shared responsibility and active participation, readiness for discharge, and follow-up.

Information transfer

Most patients felt that they were well educated and counseled when they were enrolled for the ERAS program. However, some reported that too much information was given at the same time so that they were unable to remember everything, nor were they able to think over to raise questions (Table 4- 1). Therefore, it is preferable that the written information was provided one week before surgery.

Professional support

Most patients reported that they acknowledged that it was natural to experience pain/fatigue/nausea associated with surgery and anesthesia, and they were prepared for that in some extent. When they were enrolled for the ERAS program, they expected that the program may help in alleviating these discomfort postoperatively.

Even though the results have proved that more patients in the ERAS group reported mild pain on POD1 and shortened duration of pain than those in the control group,[4] a few patients were dissatisfied with the management of postoperative pain. The different degrees of satisfaction with postoperative pain management could be explained by the subjectivity of pain and individualized experiences of receiving and tolerating analgesia. However the patients mentioned that they did feel better when the caregivers showed great empathy and responded to their complains promptly and actively (Table 4- 2.1). In contrast, they felt worse when some caregivers simply assured them that "it was not uncommon" (Table 4- 2.2). It is valuable for the caregivers to contribute to a positive feeling. Similar issue existed concerning PONV (Table 4- 2.3).

Some patients also reported that the amount of attention they received declined significantly after the first couple of PODs. They felt that some caregivers did not behave patiently enough in listening and responding to their questions and concerns when they have undergone the most intense period postoperatively and seemed "stable" compared to other patients (Table 4- 2.4,2.5).

Shared responsibility and active participation

Though all the patients were excited when they were educated preoperatively that they would be able to drink/eat and ambulate sooner than they expected after surgery, some showed a concern of "being obliged to do so" (Table 4- 3.1). Some felt that the process of accelerated recovery was designed by the caregivers and they were passively striving hard to meet the individual goals preset by the protocol which sometimes ended up with unpleasant experiences (Table 4- 3.2).

In addition, some patients mentioned that they dislike the feeling of being told to follow the "rigid" instructions in their recovery process, instead it would be better if they could play a more active role in setting their own targets from day to day after surgery (Table 4- 3.3).

Readiness for discharge

Many patients expressed their excitement with early discharge, which was also associated with reduced total cost of hospitalization[4] and faster return to normal life

and work. However a few felt that they were not ready to be discharged because a) they were still having mild symptoms (Table 4- 4.1, 4.2); b) they worried that their caretakers might not be able to take care of them at home as good as the caregivers did at the hospital (Table 4- 4.3); c) they felt that it would safer for them to stay in the hospital for a prolonged period of time if any late onset postoperative complications may occur (Table 4- 4.4, 4.5).

Follow-up

All patients praised for the convenience in contacting their primary doctors and relatively prompt response to their questions post discharge in the current study (Table 4- 5). We have been using social media cellphone/website app to contact patient, answer questions, identify possible complications, provide guidance, arrange follow-up visits, and offer support to patients in a timely fashion. This doubtlessly helps patients to alleviate their worry about "being untended" and increase their sense of security upon early discharge.

Discussion

In order to improve health care quality, thorough study of the target population is doubtlessly of great significance to meet the requirements and expectations of individual patients. Patient-oriented outcome measures including functional recovery (e.g. KPS) and patient satisfaction are employed for quality evaluation. We have validated the benefits of a neurosurgical ERAS program in shortening LOS of patients undergoing craniotomy without increasing complication rates.[4] The current study further proved that patients in the ERAS group had higher overall satisfaction as well as higher satisfaction with individual domains including information, medical care, nursing care, and enhanced recovery. Thus, it is possible to provide the patients with satisfactory information, care and treatment during a shortened hospital stay. This highly satisfaction perceived by the patients, which represents patient-based assurance of quality, should be considered as one of the most important end points for any study evaluating the quality of hospital stay associated with the interventions (such as an ERAS program).

Multivariate analysis revealed that higher ASA grade was the only independent predictor of a higher patient satisfaction in the ERAS group, whereas older age and lower ASA grade were independent predictors in the control group. These predictors can be interpreted as determinants of patient satisfaction in each group under circumstances in which most other factors do not vary significantly within each group. It is also understandable that mild PONV VAS, absorbable skin suture, and shorter postoperative LOS, which are among the key distinguishing factors between the two groups, were independent predictors for patient satisfaction in all patients. Age was also a predictor for patient satisfaction in all patients, which is in accordance with previous studies showing that older patients tend to have higher satisfaction scores with hospital health care.[9-11]

Intriguingly, ASA grade was shown to be a significant predictor of patient satisfaction in the ERAS and control group respectively with opposite direction of association; the lower ASA grade, the higher patient satisfaction in control group, whereas the higher ASA grade, the higher patient satisfaction in the ERAS group. In general, patient satisfaction appears to be higher in patients with better self-reported health status as shown in prior studies,[10 11] which is in accordance with the findings in the control group. On the other side, the benefits of the ERAS protocol may account for better satisfaction in patients with higher ASA grade. Satisfaction is a balance between patients' expectations for care and occurrence of care which is actually delivered,[12] and thus reflects changes in health status due to the effectiveness of hospital care. It is possible that for patients with higher ASA grade the ERAS-related interventions have made more profound change in self-perceived health status compared to those with lower ASA grade.

Postoperative LOS was established as an independent predictor for patient satisfaction in all patients in the current study. In addition, it was also related to specific satisfaction domains such as medical care and enhanced recovery in the ERAS group as well as in all patients. The shorter the LOS, the higher the satisfaction, which seems rational and has been shown in other studies as well.[9 11 13]

Bias associated with questionnaire surveys of satisfaction has been recognized as

patients tend to overly positively scored the care they received.[14] Furthermore, patients' explicitly positive attitude toward accelerated discharge actually masks their concerns and complains.[15] Therefore patient experience data may provide with more information in assessing the quality of care to identify the circumstances surrounded the key ERAS components which make the patients satisfactory (or not) as well as the associated reasons.[16]

In the absence of previous relevant study on patient experience in participating a neurosurgical ERAS program, we have conducted a secondary analysis of patient experience at 30-day follow-up after discharge. Based on our results, the 5 different themes were closely related to each other and represent both positive and negative sides. They showed shortcomings of care which warrant improvement in future as well as strong points which may be considered for generalization.

There is no doubt that information transfer the first and foremost step of incorporating patients into an ERAS program. It calls to attention the importance of having the ERAS conversation at least one week before surgery to allow the patients to have enough time to understand the process and raise questions. It was shown that receiving information at appropriate times improved patient satisfaction with their discharge planning.[17 18] This is practical for elective surgeries and should be adopted in future practices.

It is notable that emotional support from healthcare professionals is as crucial as medical interventions in symptom management. When facing dilemmas of burdensome symptoms and expectations for rapid recovery, the patients need to mobilize courage and will to follow the ERAS regimen. Though interventions associated with ERAS protocol have been proved to improve management of postoperative pain and PONV significantly,[4] it is perceived by patients from both previous studies[17 19] and ours that professional's empathy and supportive behavior function as decisive factors in accomplishing objectives of the ERAS program. In addition, as healthcare professionals are often enthusiastic in counseling the patients in the beginning of the study, it is important for them to being responsive to patients' need throughout the hospital stay.

It was overlooked in the practice of current study that the patients need to take responsibilities for their own to achieve an accelerated recovery and good result. They should be encouraged to act more actively and set their own daily goals after surgery. In addition to the shared responsibility and active participation required for the patients,[1 19] they also possess the right to adjust their goals based on their individualized conditions. The supportive role of caregivers should preferably be more like an assistant than a leader to hasten recovery.

It remains a hot and tough issue of patients expressing insecurities about early discharge in several studies on patient experience of ERAS programs. The most common concerns were associated with pain management, mobilization, identifying postoperative complications and lack of family support.[5 15 19 20] Our patients mentioned all these concerns as well. However, our strategy of follow-up with social media cellphone/website app in a timely and responsive manner has proved to be effective in enhancing patients' sense of security and improving their experience after discharge. It is less manpower-relied compared to follow-up visits in person or via phone calls, and benefits the patients significantly. The patients felt that the healthcare providers were still reachable and responsive through the app after discharge. By using the app not only can the medical staffs track and collect follow-up data from the patients, but also can they answer patients' questions, address concerns, guide rehabilitation, identify possible newly onset complications and schedule clinic visits. Therefore patients' traditional beliefs of "safer and necessary prolonged convalescence at hospital" would no longer be a barrier to early discharge in the ERAS program.

One limitation of the current study is that the findings from a single institution with sampled participants can not be automatically generalized. For one thing, sampling bias may exist. For anther, the possible relationship of patients' views and their personal/domestic characteristics were not well studied in the qualitative analysis. Another limitation is the lack of dedicated sample size calculation for outcomes measured in this study since patient satisfaction was a secondary outcome of the main trial.[4] Nevertheless, the risk of an underpowered sample size was to some extent

counter-balanced by a post-hoc power analysis for patient satisfaction, which yielded a post-hoc power of 100%. Above all things, the views of patients in the control group who received conventional perioperative care were not taken into account in the qualitative analysis either. However, the quantitative analysis which showed higher patient satisfaction with the ERAS program goes some towards validating the qualitative findings.

In addition to patient satisfaction, medical cost reduction should be highly valued as well given the increasing cost burden posed on both the patients and public finance. To this end, ERAS programs may play an important role in quality improvement with cost-effective care.

Conclusions

Patients in the ERAS group demonstrated higher satisfaction compare with the controls. Factors including age, PONV VAS, absorbable skin suture, and postoperative LOS were independent predictors for overall patient satisfaction. Patients value adequate and consistent information transfer as well as professional support in participating an ERAS program. It is also important to encourage the patients to take active roles and take responsibilities for their own in accelerating recovery. Timely and responsive follow-up modality after discharge could enhance patients' sense of security. The findings of the current study may serve as a stepping stone to promote further research into the evaluation and validation of patient satisfaction and experience in order to improve service delivery and patient care.

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Table 1. Sociodemographic and clinical features

Variable	ERAS group	Control group	p Value
	No. of patients (%)		
No. of patients	70	70	
Age (years)			0.612
<50	33 (47.1)	36 (51.4)	
50-65	37 (52.9)	34 (48.6)	
Sex (Male/Female)	22/48	26/44	0.476
BMI			0.617
<18.5	3 (4.3)	3 (4.3)	
18.5 ~ 23.9	47 (67.1)	52 (74.3)	
>24	20 (28.6)	15 (21.4)	
Education			0.164
No education	4 (5.7)	0 (0)	
Primary school	8 (11.4)	5 (7.1)	
Secondary school/high school	34 (48.6)	39 (55.7)	
College/more than college	24 (34.3)	26 (37.1)	
Occupation			0.352
Employed	29 (41.4)	31 (44.3)	
Homemaker	18 (25.7)	14 (20.0)	
Unemployed	12 (17.1)	19 (27.1)	
Student	3 (4.3)	3 (4.3)	
Retired	8 (11.4)	3 (4.3)	
Marital status			> 0.999
Unmarried (Single/divorced)	5 (7.1)	5 (7.1)	
Married	65 (92.9)	65 (92.9)	
ASA grades			0.410
Grade I	13 (18.6)	17 (24.3)	
Grade II	57 (81.4)	53 (75.7)	
Intracranial lesions			0.779
Meningioma	38 (54.3)	30 (42.9)	
Vestibular Schwanoma	7 (10.0)	9 (12.9)	
CPA epidermoid cyst	6 (8.6)	8 (11.4)	
Glioma	13 (18.6)	18 (25.7)	
Trigeminal neuralgia	3 (4.3)	3 (4.3)	
Cavernous malformation	3 (4.3)	2 (2.9)	

BMI = body mass index, ASA = American Society of Anesthesiologists', CPA = cerebellopontine angle

Table 2. Variables associated with surgery and accelerated recovery regimen

Variable	ERAS group	Control group	p Value
	No. of patients (%)		
No. of patients	70	70	
Length of procedure (hrs)			0.180
<3	15 (21.4)	22 (31.4)	
≥3	55 (78.6)	48 (68.6)	
Blood loss during surgery (ml)			0.310
<300	30 (42.9)	36 (51.4)	
≥300	40 (57.1)	34 (48.6)	
PONV VAS			0.115
Mild (1-4)	60 (85.7)	50 (71.4)	
Moderate (5-6)	7 (10.0)	15 (21.4)	
Severe (7-10)	3 (4.3)	5 (7.1)	
Preoperative carbohydrate loading			<0.0001
Yes	64 (91.4)	0 (0)	
No	6 (8.6)	70 (100.0)	
Absorbable skin suture			<0.0001
Yes	54 (77.1)	0 (0)	
No	16 (22.9)	70 (100.0)	
Mechanical prophylaxis for DVT			<0.0001
Yes	45 (64.3)	11 (15.7)	
No	25 (35.7)	59 (84.3)	
Removal of urinary drainage (hrs)			<0.0001
≤6	52 (74.3)	0 (0)	
>6	18 (25.7)	70 (100.0)	
Time to first oral solid intake (hrs)			<0.0001
≤24	38 (54.3)	12 (17.1)	
>24	32 (45.7)	58 (82.9)	
Ambulation on POD 1			<0.0001
Yes	45 (64.3)	0 (0)	
No	25 (35.7)	70 (100.0)	
Postoperative wound drainage			<0.0001
No	58 (82.9)	2 (2.9)	
Yes	12 (17.1)	68 (97.1)	
Pain VAS on POD1			<0.0001
Mild (1-4)	55 (78.6)	23 (32.9)	
Moderate (5-6)	13 (18.6)	42 (60.0)	
Severe (7-10)	2 (2.9)	5 (7.1)	
Postoperative LOS (d)			<0.0001
≤4	32 (45.7)	7 (10.0)	
>4	38 (54.3)	63 (90.0)	

DVT = deep vein thrombosis, LOS = length of stay, POD = postoperative day, PONV

= postoperative nausea and vomiting, VAS = visual analog scale

Table 3. Patient satisfaction scores at discharge

Variable	ERAS group	Control group	p Value
	Median (range)		
Overall Satisfaction	92.2 (85 ~ 100)	86.8 (50 ~ 100)	0.0001
Information	17.4 (15 ~ 20)	16.5 (12 ~ 20)	0.039
Medical care	18.9 (15 ~ 20)	18.3 (15 ~ 20)	0.043
Nursing care	19.2 (17 ~ 20)	18.6 (15 ~20)	0.032
Enhanced recovery	18.5 (15 ~ 20)	15.7 (10 ~20)	< 0.0001
Comfort & others	18.2 (14 ~ 20)	17.9 (12 ~20)	0.317

Table 4. Quotes from patients

Theme	Quotes
1. Information transfer	1.1 “Well you know it’s a good thing but there’s simply too much information out there. So I said to myself ok just let the doctors and nurses tell me what to do next. I’ll follow the instructions as long as I know they mean good.” (#6) 1.2 “They spent quite some time to explain the document point by point. It sounds great. Everybody wants a better outcome. Then they asked me if I had any questions. Well I could not think of any right away. They said I would keep one copy of the documents and I’m welcomed to ask questions at any time. But later on the nurses came for the pre-op stuff, then the barber, then the anesthetist, and the OR nurses. I was preoccupied with the surgery I didn’t even give them a second look. It would be better if they gave me the documents some time earlier rather than only two days before surgery.” (#9)
2. Professional support	2.1 “They gave me a patient-controlled analgesia pump for the first couple of days after surgery and it really helped a lot. I didn’t feel much pain at that time. But things changed the third day when they switched the pump to oral painkillers. It seemed to me that the oral painkillers helped little. I didn’t expect that I’d suffered from surgical pain starting on POD3. Of course I asked for help. Then came this very patient and intellectual nurse. She spent some time to explain to my family and me about the necessity of switching the pump to oral pills. She also told us that the drug used in the pump was the similar type as the oral ones. She mentioned in the end that she could ask the doctors to refill my pump if I really need that. Then I thought well, if I want to go home early I can not rely on the pump. I didn’t refill the pump and the pain did subside as time went by. Also, she checked on me later that day before the shift of duty and the next morning the first thing she came to the ward. I was able to be discharged a couple of days later, going home with oral painkillers. I was very thankful to her.” (#29) 2.2 “I knew it was natural to had pain because of the surgery but it was intense. I expected the doctor to do something but he just told me ‘It is not uncommon. If I were you I’d have the pain too.’ It was not helping.” (#26) 2.3 “The smell of food made me really nausea and I didn't want to eat at all. I called the nurse and then she called in a doctor. He checked my order of drugs and said they already give me drugs for the nausea and it was natural because there’s certainly some swelling in my brain due to the surgery.” (#5)

	2.4 “It felt like that they really wanted me to join the program and they really wanted to make sure that I met the milestones. Removal of urinary drain, oral liquid and then solid food intake, off-bed activity… I thought I did everything great. I was proud of myself and grateful to the healthcare team. But after that I felt like I was abandoned. They were probably busy helping others who were not doing great as I did…” (#40) 2.5 “In the beginning when the nurses had their shifts in front of my bed they would remind each other ‘this is an ERAS patient’ and I know it means something different. I can tell that they paid more attention to me than to other patients... Later on they were talking like ‘this is an ERAS patient and he already got off bed yesterday’ Then I became the one who doesn't deserve their attention.” (#13)
3. Shared responsibility and active participation	3.1 “You signed the consent and you made a commitment. You are obliged to stay strong and comply with the rules. It is a sort of pressure.” (#40) 3.2 “The second afternoon after I had my surgery the nurse came in to remind me that it was time for me to get off bed and try to walk according to the schedule. Yes I could fetch my meals and they had removed the drip. But I was not feeling well enough. I had some faintness. I asked ‘maybe we can try tomorrow morning?’ but she kept telling me that how other managed to walk on the second day after surgery and that ‘nobody was ready enough for that’. I didn’t want to annoy her so I tried. I could not recall what happened next because I passed out. She was scared of course. She came to apologize to me the next day. I don’t blame her personally but they should have a mechanism to adjust the goal and not to take them as fixed rules.” (#25) 3.3 “A nurse came in and she shouted ‘how come you’re still in bed? You don’t have any IV fluids today and now try to walk’. But I already walked and I even walked two rounds in the corridor earlier that morning. She did not come early enough to see that… I’m not a soldier to follow the rigid instructions as when to do what.” (#15)
4. Readiness for discharge	4.1 “When he [resident] reported to the senior doctor that ‘she’s going to be discharged today’ I thought what’s going on, he must be insane. I was not well enough. I’m stilling having this right facial paralysis. I still can’t close my right eye tightly” (#20) 4.2 “I was happy to go home only 3 days after surgery, but I wasn’t totally pain free at that time. I couldn’t help thinking maybe I should stay for another couple of days and then go home in a better condition?” (#9)

5. Follow-up	4.3 “Here in the hospital my son and daughter are around. They are using their annual leave for my hospitalization. But once I go home they’ll have their own family and children to look after… They live quite far away… My husband, he has never done any housework at home. If I don’t cook, he will starve. How can you expect him to take care of me?” (#7) 4.4 “My daughter really devoted herself to helping me recover from the surgery and I know that she wanted me home. But she is not a nurse anyway. I simply believe that it is safer to stay in the hospital. You are surrounded by medical staff so if there’s anything going wrong they will find it out and deal with it quickly.” (#23) 4.5 “I don’t trust the community hospitals and I will certainly go back to the hospital where I had my surgery if anything is wrong. I’m not living close to the hospital. And I know that it’s a busy center and there is a huge number of patients to be admitted. What if they can’t guarantee a bed if I need readmission?” (#40) 5.1 “This cell phone app works way much better than phone calls. I never called the ward even though I had the number. You nerve know whether the people answers the phone really know whom you are. But it is the doctor who did my surgery and took care of me that is now interacting with me on this app. He knows my condition.” (#20) 5.2 “I know that the doctors are always busy doing the surgeries and dealing with new patients so you don’t want to bother them in the middle of their work. I just left a message to my doctor and whenever he got time he would reply or call back. In this way my questions are answered and I don’t feel myself as a burden to him.” (#9) 5.3 “The third day after I went home I had a funny feeling around the wound. There was a small lump next to the wound which felt soft. My son took a picture of that with his cell phone and sent it to the doctors. They called me to go to the clinic. It turned out that I developed some water under the scalp and they fixed it easily. That was unimaginably convenient.” (#21)

Supplemental Table 1. Univariate analysis for predictors of satisfaction in the ERAS group

Variable	Patient satisfaction											
	Overall Satisfaction		Information		Medical care		Nursing care		Enhanced recovery		Comfort & others	
	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value	Mean (95% CI)	P value
Age (yrs)		0.332		0.070		0.915		0.784		0.852		0.650
<50	91.6 (89.7 ~ 93.5)		16.9 (16.1 ~ 17.6)		19.0 (18.5 ~ 19.4)		19.1 (18.7 ~ 19.5)		18.5 (17.7 ~ 19.2)		18.1 (17.5 ~ 18.8)	
≥50	92.8 (91.0 ~ 94.7)		17.8 (17.1 ~ 18.5)		18.9 (18.3 ~ 19.5)		19.2 (18.8 ~ 19.6)		18.5 (17.9 ~ 19.2)		18.3 (17.7 ~ 18.9)	
Sex		0.770		0.865		0.614		0.522		0.757		0.639
Male	92.5 (89.6 ~ 95.4)		17.5 (16.2 ~ 18.7)		19.1 (18.4 ~ 19.8)		19.3 (18.7 ~ 19.9)		18.6 (17.7 ~ 19.6)		18.1 (17.0 ~ 19.1)	
Female	92.1 (90.7 ~ 93.6)		17.4 (16.8 ~ 17.9)		18.9 (18.5 ~ 19.3)		19.1 (18.8 ~ 19.4)		18.5 (17.9 ~ 19.0)		18.3 (17.8 ~ 18.8)	
Education		0.795		0.525		0.142		0.864		0.623		0.187
No education/Primary	91.9 (87.4 ~ 96.3)		17.8 (16.2 ~ 19.4)		18.4 (17.0 ~ 19.8)		19.1 (18.6 ~ 19.7)		18.3 (17.4 ~ 19.4)		18.4 (17.4 ~ 19.4)	
Secondary/College	92.3 (91.0 ~ 93.7)		17.3 (16.8 ~17.9)		19.1 (18.7 ~ 19.4)		19.2 (18.9 ~ 19.5)		18.2 (17.7 ~ 18.7)		18.2 (17.7 ~ 18.7)	
Occupation		0.280		0.624		0.105		0.019		0.955		0.485
Employed	92.9 (90.9 ~ 94.9)		17.4 (16.6 ~ 18.3)		19.4 (19.0 ~ 19.8)		19.3 (18.9 ~ 19.7)		18.4 (17.6 ~ 19.2)		18.4 (17.6 ~19.1)	
Unemployed	93.5 (89.2 ~ 97.8)		17.9 (16.2 ~ 19.6)		18.8 (17.6 ~ 19.9)		19.8 (19.4 ~ 20.1)		18.5 (17.0 ~ 20.0)		18.6 (17.5 ~ 19.7)	

Homemaker/ Student/Retired	91.0 (91.0 ~ 93.5)		17.2 (16.4 ~ 17.9)		18.6 (18.0 ~ 19.2)		18.9 (18.4 ~ 19.2)		18.6 (17.9 ~ 19.3)		18.0 (17.3 ~ 18.6)	
Marital status		0.653		0.779		0.689		0.305		0.183		0.602
Unmarried (Single/divorced)	93.3 (79.0 ~ 107.7)		17.7 (11.4 ~ 23.9)		18.7 (15.8 ~ 21.5)		18.7 (14.9 ~ 22.5)		19.7 (18.2 ~ 21.1)		18.7 (14.9 ~ 22.5)	
Married	92.2 (90.9 ~ 93.5)		17.4 (16.9 ~ 17.9)		19.0 (18.6 ~ 19.3)		19.2 (19.0 ~ 19.5)		18.4 (17.9 ~ 18.9)		18.2 (17.8 ~ 18.7)	
ASA grades		0.124		0.611		0.004		0.119		0.851		0.595
Grade I	90.3 (88.3 ~ 92.4)		17.1 (15.9 ~ 18.3)		17.9 (16.8 ~ 18.9)		18.8 (18.0 ~ 19.5)		18.4 (17.1 ~ 19.8)		18.1 (17.5 ~ 18.7)	
Grade II	92.8 (91.2 ~ 94.4)		17.4 (16.8 ~ 18.1)		19.1 (18.8 ~ 19.5)		19.3 (19.0 ~ 19.6)		18.6 (18.0 ~ 19.1)		18.4 (17.9 ~ 18.9)	
Length of procedure (hrs)		0.493		0.738		0.384		0.195		0.313		0.903
<3	91.0 (86.8 ~ 95.2)		17.5 (16.0 ~ 19.0)		18.5 (17.2 ~ 19.8)		18.8 (17.9 ~ 19.6)		18.0 (16.2 ~ 19.8)		18.3 (17.3 ~ 19.2)	
≥3	92.2 (90.7 ~ 93.7)		17.3 (16.6 ~ 17.9)		18.9 (18.5 ~ 19.3)		19.2 (18.9 ~ 19.5)		18.6 (18.1 ~ 19.2)		18.2 (17.6 ~ 18.7)	
Blood loss during surgery (ml)		0.973		0.564		0.496		0.054		0.685		0.693
<300	92.3 (90.0 ~ 94.6)		17.6 (16.7 ~ 18.5)		18.8 (18.2 ~ 19.4)		19.0 (18.5 ~ 19.4)		18.6 (17.8 ~ 19.4)		18.4 (17.8 ~ 19.0)	
≥300	92.3 (90.7 ~ 94.0)		17.3 (16.6 ~ 18.0)		19.0 (18.6 ~19.5)		19.4 (19.1 ~ 19.7)		18.4 (17.8 ~ 19.0)		18.2 (17.6 ~18.8)	

PONV VAS		0.036		0.359		0.142		0.134		0.011		0.809
Mild (1-4)	92.8 (91.5 ~ 94.1)		17.5 (16.9 ~ 18.1)		19.1 (18.7 ~ 19.4)		19.3 (19.0 ~ 19.5)		18.8 (18.4 ~ 19.2)		18.3 (17.8 ~ 18.7)	
Moderate (5-6)/Severe (7-10)	89.4 (85.3 ~ 93.5)		16.9 (15.2 ~ 18.5)		18.4 (17.0 ~ 19.8)		18.8 (17.8 ~ 19.7)		17.3 (15.2 ~ 19.3)		18.1 (16.9 ~ 19.3)	
Preoperative carbohydrate loading		0.684		0.446		0.853		0.196		0.363		0.516
Yes	92.1 (90.8 ~ 93.5)		17.3 (16.8 ~17.9)		19.0 (18.6 ~19.3)		19.1 (18.8 ~ 19.4)		18.6 (18.1 ~ 19.1)		18.2 (17.7 ~18.7)	
No	92.9 (88.3 ~ 97.4)		17.9 (16.4 ~ 19.3)		18.9 (17.5 ~ 20.2)		19.6 (19.1 ~ 20.1)		18.0 (16.3 ~ 19.7)		18.6 (17.4 ~19.8)	
Absorbable skin suture		0.071		0.977		0.004		0.543		0.011		0.982
Yes	92.8 (91.4 ~ 94.2)		17.4 (16.8 ~18.0)		19.2 (18.8 ~ 19.5)		19.2 (18.9 ~ 19.5)		18.8 (18.3 ~ 19.2)		18.3 (17.7 ~ 18.8)	
No	89.8 (86.9 ~ 92.6)		17.4 (15.9 ~ 18.9)		17.9 (16.6 ~ 19.2)		19.0 (18.4 ~ 19.6)		17.3 (15.8 ~ 18.7)		18.3 (17.7 ~ 18.8)	
Mechanical prophylaxis for DVT		0.724		0.695		0.553		0.787		0.422		0.693
Yes	92.3 (90.6 ~ 94.0)		17.4 (16.7 ~18.1)		19.0 (18.6 ~ 19.4)		19.2 (18.9 ~ 19.6)		18.4 (17.8 ~ 19.0)		18.3 (17.7 ~ 18.9)	
No	92.8 (90.7 ~ 94.9)		17.6 (16.7 ~ 18.5)		18.8 (18.1 ~ 19.5)		19.2 (18.7 ~ 19.6)		18.8 (18.0 ~ 19.5)		18.4 (17.9 ~ 19.0)	

Removal of urinary drainage (hrs)		0.421	0.298	0.777	0.240	0.816	0.664
≤6	91.9 (90.5 ~93.4)	17.2 (16.6 ~ 17.8)	19.0 (18.5 ~ 19.4)	19.1 (18.8 ~ 19.4)	18.5 (17.9 ~ 19.0)	18.2 (17.7 ~ 18.8)	
>6	93.1 (90.2 ~ 96.0)	17.8 (16.7 ~ 18.9)	18.9 (18.3 ~ 19.5)	19.4 (19.1 ~ 19.8)	18.6 (17.7 ~ 19.5)	18.4 (17.7 ~ 19.1)	
Time to first oral solid intake (hrs)		0.947	0.709	0.559	0.434	0.399	0.549
≤24	92.2 (90.4 ~ 94.0)	17.5 (16.8 ~ 18.2)	18.8 (18.3 ~ 19.4)	19.1 (18.7 ~ 19.5)	18.7 (18.1 ~ 19.3)	18.1 (17.5 ~ 18.7)	
>24	92.3 (90.3 ~ 94.3)	17.3 (16.4 ~ 18.1)	19.1 (18.6 ~19.5)	19.3 (18.9 ~ 19.6)	18.3 (17.5 ~ 19.1)	18.4 (17.7 ~ 19.0)	
Ambulation on POD 1		0.996	0.774	0.821	0.483	0.630	0.542
Yes	92.2 (90.6 ~ 93.9)	17.5 (16.8 ~ 18.1)	19.0 (18.5 ~ 19.5)	19.1 (18.7 ~ 19.5)	18.6 (18.0 ~ 19.2)	18.1 (17.6 ~ 18.7)	
No	92.2 (90.0 ~ 94.5)	17.3 (16.4 ~ 18.2)	18.9 (18.3 ~ 19.4)	19.3 (19.0 ~ 19.6)	18.4 (17.5 ~ 19.2)	18.4 (17.7 ~ 19.1)	
Postoperative wound drainage		0.246	0.977	0.142	0.864	0.081	0.809
No	92.6 (91.2 ~ 94.0)	17.4 (16.8 ~ 18.0)	19.1 (18.7 ~ 19.4)	19.2 (18.9 ~ 19.5)	18.7 (18.2 ~ 19.2)	18.3 (17.8 ~ 18.8)	
Yes	90.6 (87.1 ~ 94.1)	17.4 (16.0 ~ 18.7)	18.4 (17.5 ~ 19.3)	19.1 (18.6 ~ 19.7)	17.6 (16.4 ~ 18.9)	18.1 (17.2 ~ 19.1)	

Pain VAS on POD1		0.006		0.853		0.054		0.001		0.020		0.067
Mild (1-4)	93.1 (91.7 ~ 94.5)		17.4 (16.8 ~18.0)		19.1 (18.8 ~19.5)		19.4 (19.1 ~ 19.7)		18.8 (18.3 ~ 19.3)		18.4 (18.0 ~18.9)	
Moderate (5-6)/Severe (7-10)	89.0 (86.7 ~ 91.3)		17.3 (16.3 ~ 18.3)		18.3 (17.2 ~ 19.4)		18.4 (18.0 ~ 18.8)		17.5 (16.3 ~ 18.7)		17.5 (16.4 ~ 18.6)	
Postoperative LOS (d)		0.219		0.971		0.017		0.829		0.045		0.837
≤4	93.1 (91.0 ~ 95.2)		17.4 (16.6 ~ 18.2)		19.4 (19.0 ~ 19.8)		19.2 (18.7 ~ 19.6)		19.0 (18.4 ~ 19.6)		18.2 (17.4 ~ 19.0)	
>4	91.5 (90.0 ~ 93.2)		17.4 (16.7 ~ 18.1)		18.6 (18.0 ~ 19.1)		19.2 (18.9 ~ 19.5)		18.1 (17.4 ~ 18.8)		18.3 (17.8 ~ 18.8)	

ASA = American Society of Anesthesiologists', DVT = deep vein thrombosis, LOS = length of stay, POD = postoperative day, PONV = postoperative nausea and vomiting, VAS = visual analog scale

Additional file 1 Summary of the questions included in the patient satisfaction questionnaire at discharge.

Module 1- Information
- Information delivery
- Patient counseling
- Doctors' and nurses' interest in patients' questions
- Contradictory orders

Module 2- Medical care
- Experience of operation
- Doctors' rounds
- Postoperative symptom management
- Explanations about health condition & treatment

Module 3- Nursing care
- Preoperative preparation
- Postoperative nursing care
- Nurses' empathy
- Response to patient/family need

Module 4- Enhanced recovery
- Nutritional intervention
- Functional recovery assistance
- Discharging criteria & follow-up arrangement
- Outcome of surgery/hospitalization

Module 5- Comfort & others
- Environmental conditions
- Sense of security
- Cost
- Administration & logistics

Additional file 2 Semi-structured interview guide at 30-day follow-up after discharge.

Warm up

- Self introduction
- Thank patient for participating and confirm consent verbally
- Assess 30-day follow-up KPS

General questions

- How did you feel about the recent hospital stay and the ERAS program?
- What concerns you most about the ERAS program?
- What do you recall in participating the ERAS program?

Information transfer

- How did you feel about the education and counseling when you were enrolled for the ERAS program?
- Do you recall any differences between the written information and verbal information?
- Did the doctors' and nurses' respond to your questions and concerns adequately?

Symptom management & accelerated recovery

- What were your expectations about pain/fatigue/nausea and vomiting after surgery?
- Was symptom control better/worse than you expected?
- How was your recovery process after surgery? Was it faster/slower than you expected? Was it harder/easier than you expected?

Discharge & follow-up

- How did you feel about the time and condition at discharge? Did you feel ready to be discharged? Did you have any concern about early discharge?
- Did you have any discomfort or problem after discharge? Did you get any help/guidance from the primary doctors?
- How was your family support after discharge?

Cool down

- Encourage patient to talk about their experience/concerns/suggestions not mentioned in the previous questions

Standards for Reporting Qualitative Research (SRQR) [a] checklist

No.	Topic	Item	Reported on page No
	Title and abstract		
S1	Title	Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	1
S2	Abstract	Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	3-4
	Introduction		
S3	Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	4-5
S4	Purpose or research question	Purpose of the study and specific objectives or questions	5
	Methods		
S5	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale[b]	7
S6	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	7
S7	Context	Setting/site and salient contextual factors; rationale[b]	7
S8	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale[b]	7
S9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	7-8
S10	Data collection methods	Types of data collected; details of data collection procedures including (as	5-7

		appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale[b]	
S11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	7, Additional file 2
S12	Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	7, 9,11
S13	Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/deidentification of excerpts	7-8
S14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale[b]	9
S15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale[b]	7-9
	Results/findings		
S16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	11-13
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Table 4
	Discussion		
S18	Integration with prior work, implications, transferability, and contribution(s) to the field	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/ generalizability; identification of unique contribution(s) to scholarship in a discipline or field	15-17
S19	Limitations	Trustworthiness and limitations of findings	17
	Other		
S20	Conflicts of interest	Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	2
S21	Funding	Sources of funding and other support; role of funders in data collection, interpretation, and reporting	2

[a]The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

[b]The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

No Item	Guide questions/description	Answer
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	BL, YW, YZ, TZ, YX, LC, YW
2. Credentials	What were the researcher's credentials? *E.g. PhD, MD*	MD, PhD
3. Occupation	What was their occupation at the time of the study?	Doctors
4. Gender	Was the researcher male or female?	Female: BL, Male: all others
5. Experience and training	What experience or training did the researcher have?	Finished residency training in Neurosurgery: BL, YZ, YX, YW Ongoing residency training in Neurosurgery: YW, TZ, LC
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	Yes
7. Participant knowledge of the interviewer	What did the participants know about the researcher? *e.g. personal goals, reasons for doing the research*	Reasons for doing the research
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? *e.g. Bias, assumptions, reasons and interests in the research topic*	Reasons and interests in the research topic
Domain 2: Study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? *e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis*	Phenomenology
Participant selection		
10. Sampling	How were participants selected? *e.g. purposive, convenience, consecutive, snowball*	Purposive
11. Method of approach	How were participants approached? *e.g. face-to-face, telephone, mail, email*	Telephone
12. Sample size	How many participants were in the study?	46
13. Non-participation	How many people refused to participate or dropped out? Reasons?	0
Setting		

14. Setting of data collection	Where was the data collected? *e.g. home, clinic, workplace*	Home
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	Yes, sometimes patients' relatives.
16. Description of sample	What are the important characteristics of the sample? *e.g. demographic data, date*	Demographic data varies
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Yes (see Additional file 2). Not pilot tested.
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes audio recording
20. Field notes	Were field notes made during and/or after the interview or focus group?	Yes during and immediately after the interview
21. Duration	What was the duration of the interviews or focus group?	15~30 min
22. Data saturation	Was data saturation discussed?	Yes
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: Analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	3
25. Description of the coding tree	Did authors provide a description of the coding tree?	No
26. Derivation of themes	Were themes identified in advance or derived from the data?	Derived from data
27. Software	What software, if applicable, was used to manage the data?	NA
28. Participant checking	Did participants provide feedback on the findings?	Yes
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? *e.g. participant number*	Yes. Identified with participant number.
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major	Were major themes clearly presented in the findings?	Yes

themes		
2. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	No