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Original article

Venous Thromboembolic Complications of Surgical Excision of Meningioma: A Retrospective Trial to Suggest Perioperative Risk Factors

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BACKGROUND: Venous thromboembolic events (VTE) are perioperative complications that may follow surgical resection of intracranial meningiomas and may carry significant morbidity. Various risk factors for the development of these complications have been previously studied.

OBJECTIVES: This retrospective study targets to assess the applicability of perioperative data for early prediction of the possibility of development of oncoming VTE after surgery for intracranial meningioma surgery.
PATIENTS AND METHODS: The files of 464 patients with meningiomas, with complete perioperative data, were reviewed for the development of postoperative venous thromboembolic events (PO-VTE). The relation of PO-VTE development to patients' demographic and clinical data, lesion-related data, preoperative data, operative data and postoperative data were analyzed.

RESULTS: Files of 27 patients (5.82%) indicated the development of PO-VTE (VTE group). The incidence of PO-VTE was positively correlated with patients' age, body mass index (BMI), current smoking, presence of co-morbidities, paretic limb or recurrent intracranial lesion and with prolonged operative time, intensive care unit (ICU) stay and hospital stay. The receiver operating characteristic (ROC) curve analysis and multivariate regression analysis defined old age and presence of comorbidities as the most significant preoperative predictors. The ROC curve analysis also defined recurrent meningioma and prolonged ICU stay as the significant operative and postoperative predictors, but multivariate analysis excluded prolonged ICU stay as a significant predictor for PO-VTE. Multivariate regression analysis for combination of these variables defined older age, recurrent intracranial lesion and long recumbency in ICU as complementary factors for increasing the incidence of PO-VTE.

CONCLUSION: The VTE events are not uncommon complications of meningioma excision. Older age is a predictor for oncoming PO-VTE especially in patients who had recurrent lesion, associated comorbidities, high BMI, and long ICU stay.

KEYWORDS: Deep venous thrombosis, Early perioperative predictors, Intracranial meningioma, Postoperative venous thromboembolic events, Pulmonary embolism.

INTRODUCTION

Venous thromboembolic events (VTE) are perioperative complications experienced in all surgical branches and carry significant morbidity.[1] Routine use of perioperative VTE prophylaxis is common practice across multiple surgical specialties, but their outcomes are inconsistent.[2] Thus, efforts must be made to reduce the incidence of VTE through evaluating patients' risk factors and in light of the type of surgery to be performed.[1]

Meningioma is the most common primary intracranial (IC) tumor that account for about 37.6% of central nervous system tumors and approximately 50% of all benign brain tumors. They are classified into three grades according to the World Health Organization (WHO) grading.[3]

Surgical resection is the mainstay of meningioma treatment, so the evaluation for perioperative risk factors for major events in patients undergoing meningioma surgery can aid to optimize the rates of adverse events.[4] Patients' age, comorbidities especially cardiovascular ones and male gender are determinant preoperative risk factors for adverse events after meningioma resection.[5] Patient's age is a predictive factor of increased risk of postoperative (PO) hematoma, which is a risk factor for neurologic worsening or 30-day mortality.[6] Advanced age is a prominent risk factor for functional decline at discharge of elderly patients with surgically treated asymptomatic or minor symptom meningiomas.[7]

This study aimed to evaluate the perioperative patients' and lesions' data as early predictors for oncoming VTE events after IC meningioma surgery.

PATIENTS AND METHODS

This research was performed at Departments of Neurosurgery, Faculty of Medicine, Helwan and Tanta Universities in conjunction with Nasser Institute Hospital, Ministry of Health, Egypt. Ethical committee approval was obtained from the Ethical Committee, Helwan University with serial number 126-2023.

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This is a retrospective study through files of cases who had IC meningioma surgery along 5 year-duration and who received immediate and short-term follow-up at Helwan and Tanta University Hospitals and Nasser Institute Hospital. All these patients had previously signed the written consent to undergo surgery. Since the study was a retrospective study, the ethical committee had exempted authors from taking consents.

The study included only the files containing complete data of patients operated upon for intracranial meningiomas. The extracted data included patients' demographic and clinical data, preoperative preparation data including that of the lesion, operative data, and immediate postoperative (PO) data and short-term follow-up data. Files missing any of the data required for inclusion were excluded from the study.

Demographic data included age, gender, body mass index (BMI) that was calculated as the weight divided by squared height in meter according to Bray.8 Patients were categorized according to the WHO grades of BMI as underweight if BMI was less than 18.5 kg/m2, average weight when BMI was in range of 18.5–24.99 kg/m2, pre-obese or overweight if BMI is 25–29.99 kg/m2 and obese if BMI ≥30 kg/m2. Obesity is graded as obese grade I if BMI was 30 to 34.99 kg/m2, obese grade II if BMI was 35-39.99 kg/m2 and obese grade III if BMI was ≥40 kg/m2.9 Smoking status was classified as current smoker, ex-smoker or non-smoker.

Medical history included the presence of bleeding disorders, coagulopathy, liver disorders inducing abnormal prothrombin time and concentrations, varicose veins with or without incompetent valves or paretic limb. Furthermore, the presence of history of cardiac disorders especially cardiac valve diseases, previous cardiac interventions, cerebrovascular insults, previous deep venous thrombosis (DVT) especially if postoperative, and maintenance on anticoagulant therapy or steroid therapy for any indication was checked.

Preoperative evaluation data included routine investigations, blood group, ambulatory status that was classified as ambulatory, walking aid, wheelchair-bound, and bed ridden, and surgical fitness status according to the American Society of Anesthesiology (ASA) physical status classification system.10 Data concerning the use of pharmacologic VTE prophylaxis, preoperative use of antiplatelet agents/anticoagulants therapies, and preoperative vascular embolization for the meningioma and type of embolic material used were recorded. Also, history of previous IC meningioma surgery and if this lesion is a recurrent one was assessed.

Intraoperative (IO) data included the need for insertion of central venous pressure (CVP) catheter, localization of the meningioma as in the falx/ parasagittal region, convexity, skull base, and posterior fossa, operative time, anesthesia time, estimated IO blood loss and the number of transfused blood units.

Postoperative data included the length of stay (LOS) in ICU and in the hospital, development of nosocomial infection, neurological status at time of hospital discharge and histologic grade and subtype of the excised lesion.

Study outcomes and interpretations included the incidence of PO-VTE and its type as pulmonary embolism (PE) or DVT, which if suspected clinically was confirmed by calf muscle venous Doppler to evaluate the deep venous system. In addition, the relation between the collected perioperative data and PO-VTE was evaluated using statistical analyses to define the significant early predictors for these events.

Statistical Analysis

One-way analysis of variance (ANOVA) and Chi-Square tests were used for analysis of differences between groups. The receiver operating characteristic (ROC) curve analysis and regression analysis was applied to evaluate the ability of the perioperative data for the prediction of the possibility of VTE development. Statistical analysis was conducted using the statistical package for social sciences (SPSS) (version 25; IBM Corp, USA). Significant difference was defined at cutoff point of $p < 0.05$.

RESULTS

During data extraction, only 641 files were found to have complete patients' data, 118 files were excluded because patients developed complications irrelevant to VTE and 523 files including the full required data were reviewed. During reviewing the files, 59 files were also excluded for patients' death due to complications irrelevant to VTE and data of 464 files were extracted and analyzed. Out of these files, 27 patients (5.82%) had developed PO-VTE (VTE group) and 437 patients were discharged free of manifestations of VTE (No-VTE group). Five patients of those who had PO-VTE (18.52%), which represents 1.08% of the enrolled files, developed PE and died during their ICU stay, while 22 patients (81.48%) developed the clinical and Doppler manifestations of DVT, which represents 4.74% of the explored patients' files as illustrated in the study flow chart **(Fig. 1).**

Patients of VTE group were significantly older ($p=0.0003$) and obese ($p=0.007$) than those of No-VTE group. The frequency of current smokers ($p=0.001$) and those who had comorbidities ($p=0.031$) was higher among VTE group than the No-VTE group. However, patients' distribution according to gender ($p=0.428$) and type of comorbidities ($p=0.251$) showed insignificant difference between both groups **(Table 1).**

Nine patients (1.94%) had recurrent meningiomas with significantly ($p=0.034$) higher incidence of recurrent lesions among VTE group. According to computerized tomography (CT) and magnetic resonance imaging (MRI) findings, 8 lesions (1.72%) were located in the posterior cranial fossa, 141 lesions (30.39%) were falcine or parasagittal lesions, 70 lesions (15.1%) were located

at the skull base and 245 lesions (52.8%) were located at the skull convexity, with non-significant (p=0.535) difference between VTE and No-VTE groups. The majority of patients (n=219; 47.2%) were of blood group B, 93 patients (20%) were of blood group A, 37 patients (8%) were of group AB and 115 patients (24.8%) were of blood group O. There was insignificant (p=0.766) difference between patients as regards the distribution according to blood group. Patients' distribution according to the ASA grades also showed non-significant (p=0.673) difference between both groups. Three patients (0.65%) had preoperative paretic limb with significantly (p=0.041) higher frequency among VTE group. Five of cardiac patients (1.08%) were maintained on anticoagulant therapy with insignificantly (p=0.173) higher frequency among VTE patients **(Table 2).**

Ninety-nine patients (21.33%) required CVP catheter insertion with non-significantly higher frequency (p=0.549) among VTE group. Operative time as an average and patients' frequencies showed significant differences between both groups (p=0.025 and 0.035, respectively) in favor of No-VTE group. Patients' distribution according to LOS in ICU showed significant (p=0.0006) difference between both groups and the mean of LOS in ICU was significantly (p<0.001) longer for patients of VTE group. Patients of VTE group had significantly (p=0.040) prolonged length of hospital stay, but with insignificantly (p=0.212) higher frequency of patients who stayed for >5 days after surgery in comparison to patients of No-VTE group **(Table 3).**

The incidence of PO-VTE among meningioma patients was positively correlated with patients' age, BMI, current smoking, co-morbidities especially cardiac ones, paretic limb or recurrent intracranial lesion. Moreover, the incidence of PO-VTE was correlated with prolonged operative time and ICU stay and prolonged hospital stay **(Table 4).**

Verification of preoperative variables as correlated with the incidence of PO-VTE as early preoperative predictors for oncoming possibility of development of PO-VTE using ROC curve analysis determined older age, obesity, current smoking and associated medical comorbidities as significantly predisposing to PO-VTE **(Fig. 2)**. These variables were assured as early predictors for PO-VTE by univariate regression analysis, while multivariate regression analysis excluded obesity and smoking and assured the predictability of older age and presence of comorbidities as the most significant predictors for oncoming PO-VTE. The ROC curve analysis of operative and PO data as predictors for PO-VTE defined surgical removal of recurrent meningioma and prolonged ICU stay as significant predictors (Fig. 3) and this was assured by univariate analysis, while multivariate analysis showed that surgical intervention on recurrent meningioma is the significant predictor for PO-VTE **(Table 5)**.

Evaluation of selected variables as predictors for oncoming PO-VTE stratified these variables according to the significance of AUC as follows: old age, recurrent IC lesion, long duration of ICU stay, high BMI, presence of comorbidities, long operative time and current smoking (Fig. 4). Multivariate regression analysis defined old age, recurrent IC lesion and long recumbence in ICU as complementary factors for increasing the incidence of PO-VTE **(Table 6)**.

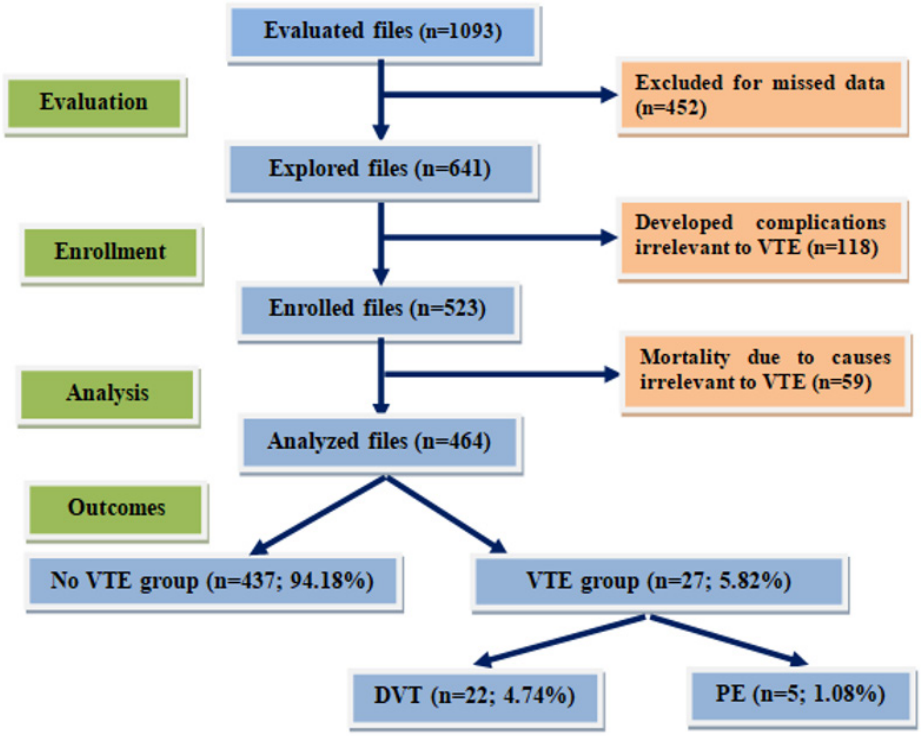

Fig 1: Study flow chart.

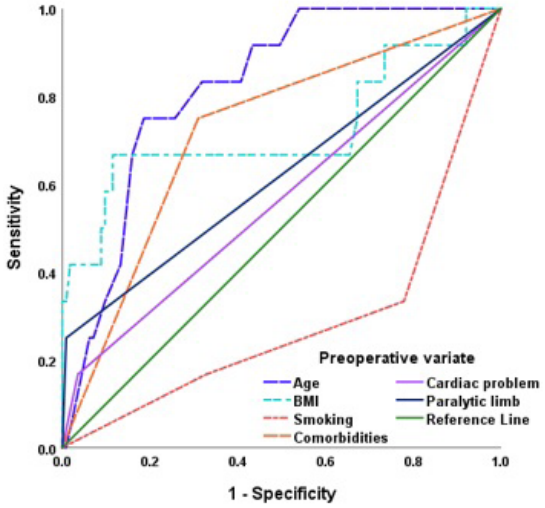

Fig 2: The ROC curve analysis for preoperative variables that were correlated with the incidence of PO-VTE as early preoperative predictors for this event.

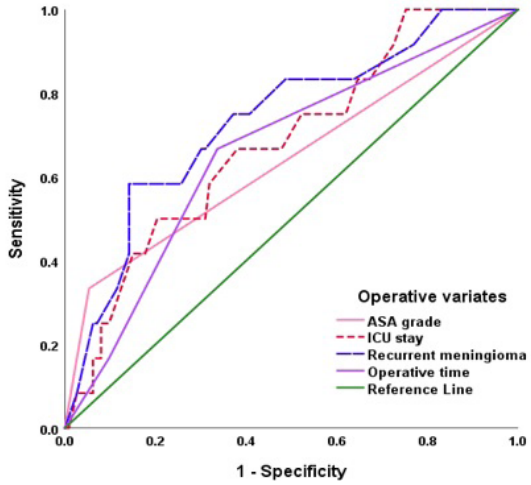

Fig 3: The ROC curve analysis for operative & PO variables that were correlated with the incidence of PO VTE as early preoperative predictors for this event.

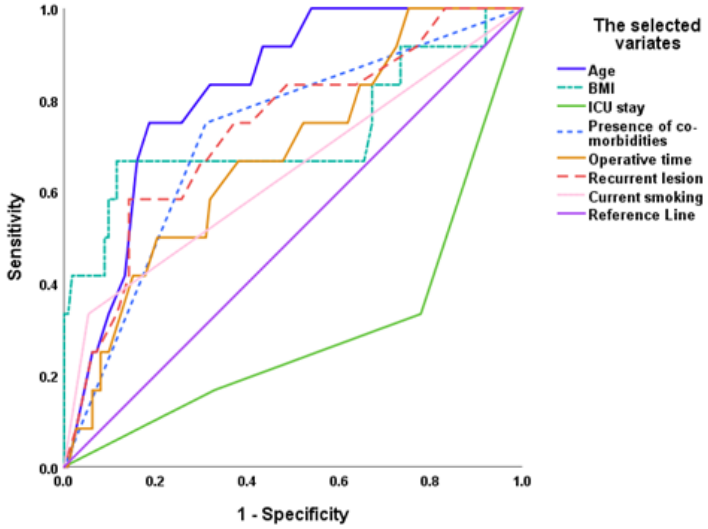

Fig 4: The ROC curve analysis for selected variables to be used in combination to predict PO-VTE as early preoperative predictors for this event.

Table 1: Patients' data

Data	Group		No VTE (n=437)	VTE (n=27)	P
Age (years)	<30		67 (15.3%)	2 (7.4%)	
	30-39		164 (37.5%)	4 (14.8%)	
	40-49		89 (20.4%)	3 (11.1%)	0.0003
	50-59		76 (17.4%)	10 (37%)	
	≥60		41 (9.4%)	8 (29.6%)	
	Average (±SD)		47.5 (11.5)	52.3 (12.6)	0.063
Gender	Males		241 (55.1%)	17 (63%)	0.428
	Females		196 (44.9%)	10 (37%)	
BMI (kg/m^2)	Overweight (25-29.9)		167 (38.2%)	7 (25.9%)	0.585
	Obese-I (30-34.9)		270 (61.8%)	20 (74.1%)	
	Average (±SD)		31.5 (2.2)	30.7 (1.5)	0.007
Smokers	Current		67 (15.3%)	11 (40.7%)	
	EX-		131 (30%)	9 (33.3%)	0.001
	Non-		239 (54.7%)	7 (25.9%)	
Co-morbidities	Frequency	Yes	41 (9.4%)	6 (22.2%)	0.031
		No	396 (90.6%)	21 (77.8%)	
	Types	Hypertension	11 (2.5%)	1 (3.7%)	
		Diabetes mellitus	8 (1.8%)	2 (7.4%)	
		Chronic kidney disease	5 (1.1%)	1 (3.7%)	0.251
		Cardiac problems	6 (1.4%)	1 (3.7%)	
		Hypercholesterolemia	11 (2.5%)	1 (3.7%)	

Table 2: Preoperative data

Data	Group		No VTE (n=113)	VTE (n=12)	P
Lesion's data	**Recurrence**	De Novo	430 (98.4%)	25 (92.6%)	0.034
		Recurrent	7 (1.6%)	2 (7.4%)	
	Lesions' location	Posterior fossa	8 (1.8%)	0	
		Falx/parasagittal	133 (30.4%)	8 (29.6%)	0.535
		Skull base	68 (15.6%)	2 (7.4%)	
		Convexity	228 (52.2%)	17 (63%)	
Patients' clinical data	**ABO Blood group**	A	88 (20.1%)	5 (18.5%)	
		B	208 (47.6%)	11 (40.7%)	0.766
		AB	35 (8%)	2 (7.4%)	
		O	106 (24.3%)	9 (33.3%)	
	ASA grade	I	324 (74.1%)	18 (66.7%)	
		II	67 (15.3%)	5 (18.5%)	0.673
		III	46 (10.6%)	4 (14.8%)	
	Presence of paretic limb	Yes	2 (0.46%)	1 (3.7%)	0.041
		No	435 (99.54%)	26 (96.3%)	
	Anticoagulant therapy	Yes	4 (0.92%)	1 (3.7%)	0.173
		No	433 (99.08%)	26 (96.3%)	

Table 3: Operative and Postoperative data

Data	Group	No VTE (n=437)	VTE (n=27)	P
Intraoperative central venous catheter insertion	Yes	92 (21%)	7 (26%)	0.549
	No	345 (79%)	20 (74%)	
Operative time (minutes)	<200	165 (37.8%)	8 (29.6%)	
	200-299	197 (45.1%)	9 (33.3%)	0.035
	≥300	75 (17.1%)	10 (37.1%)	
	Average (SD)	240 (62.5)	266.3 (61.8)	0.025
Duration of ICU stay (hours)	24	125 (28.6%)	2 (7.4%)	
	24-48	225 (51.5%)	12 (44.4%)	0.0006
	48-72	78 (17.8%)	10 (37.1%)	
	>72	9 (2.1%)	3 (11.1%)	
	Average (SD)	28.9 (14.7)	54.2 (27.9)	<0.001
Postoperative hospital stay (days)	3-days	159 (36.4%)	5 (18.5%)	
	4-days	128 (29.3%)	6 (22.2%)	0.040
	5-days	109 (24.9%)	10 (37.1%)	
	6-days	41 (9.4%)	6 (22.2%)	
	Average (SD)	4.1 (1.1)	4.6 (1)	0.212

Table 4: Relation between perioperative data and incidence of VTE

Preoperative data	r	P	Operative and PO data	r	P
Age	0.313	<0.001	**ASA grade**	0.174	0.052
Male	0.021	0.820	**CVP insertion**	0.108	0.229
BMI	0.225	0.004	**Posterior fossa meningioma**	-0.020	0.829
Current smoker	0.236	0.008	**Recurrent meningioma**	0.304	0.001
Co-morbidities	0.272	0.002	**Operative time**	0.186	0.038
Cardiac problems	0.181	0.043	**ICU stay**	0.267	0.003
ABO blood group	0.077	0.393	**Hospital stay**	0.255	0.004
Paretic limb	0.404	<0.001			
Maintenance on anti-coagulant therapy	0.056	0.532			

Table 5: Statistical analyses of perioperative data correlated with the incidence of PO-VTE as early predictors for PO-VTE

	Receiver Operating Characteristic curve analysis				Regression analysis			
					Univariate		Multivariate	
	AUC	SE	P	95% CI	β	P	β	P
Preoperative data								
Age	0.822	0.050	<0.001	0.724-0.919	0.265	0.001	0.296	0.001
BMI	0.725	0.100	0.011	0.529-0.920	0.236	0.003	Excluded	
Current smoker	0.288	0.086	0.016	0.119-0.456	0.268	0.001		
Co-morbidities	0.720	0.077	0.012	0.569-0.871	0.259	0.001	0.251	0.003
Cardiac problems	0.566	0.094	0.456	0.381-0.751	Excluded			
Paralytic limb	0.621	0.098	0.171	0.429-0.812				
Operative & PO data								
ASA grade	0.640	0.096	0.111	0.451-0.829	Excluded			
Recurrent meningioma	0.735	0.077	0.008	0.585-0.886	0.295	0.001	0.304	0.001
Operative time	0.661	0.082	0.068	0.499-0.822	Excluded			
Duration of ICU stay	0.681	0.078	0.040	0.529-0.833	0.256	0.003	Excluded	

Table 6: Statistical analyses of the selected variables to be used in combination to predict PO-VTE

	Receiver Operating Characteristic Curve				Multivariate Regression	
	AUC	SE	P	95% CI	β	P
Age	0.822	0.050	<0.001	0.724-0.919	0.273	0.001
Recurrent IC lesion	0.735	0.077	0.008	0.585-0.886	0.269	0.001
Long duration of ICU stay	0.725	0.100	0.011	0.529-0.920	0.240	0.003
High BMI	0.720	0.077	0.012	0.569-0.833	Excluded	
Presence of comorbidities	0.288	0.086	0.016	0.119-0.456	Excluded	
Long operative time	0.681	0.078	0.040	0.529-0.833	Excluded	
Current smoker	0.640	0.096	0.111	0.451-0.829	Excluded	

DISCUSSION

This retrospective study reviewed the files of patients who had elective craniotomy for IC meningioma over 5-years at three Egyptian hospitals and detected 27 cases of PO-VTE with an incidence of 5.82%, a finding indicating that PO-VTE is not a negligible complication. Twenty-two patients developed DVT, as clinically diagnosed and confirmed by venous Doppler studies, following meningioma surgery, with an incidence rate of 4.74%. Such findings supported those previously reported in the literature by Moussa and Mohamed who retrospectively diagnosed VTE in 8.2% of their series of meningioma, and by Nunno et al. who reviewed files of meningioma patients who underwent surgery through 3-years duration and reported an incidence of VTE of 3.38%.[11,12] In 2021, Fluss et al. and Khan et al. through a retrospective review of files of patients who had surgical excision of intracranial and intraspinal meningiomas detected an incidence of VTE of 4.06% and 3.4%, respectively.13,14 Recently, Abunimer et al. and Lasica et al. detected a rate of PO-VTE of 9.59% and 5.7% in cases who had meningioma surgery, respectively.[15,16] In 2023, Rizzo et al. detected cumulative incidence for VTE of 8.7% after meningioma surgery.[17]

Five cases had embolic complications and died during their ICU stay, with an incidence of PO pulmonary embolism of 1.07%. In line with this finding, an earlier study that encompassed 581 consecutive patients detected an incidence of PE of 4.6% in cases who had surgery for IC meningiomas through 12-years evaluation.[18] Furthermore; recent retrospective studies reported an incidence of PE of 1.47% and 1.96% after elective surgery for IC meningioma.[12,15] These figures assured the suggestion provided by the current study that PO-VTE are not uncommon complications of elective IC meningioma surgery.

Multiple studies tried prophylactic low molecular weight heparin (LMWH) and/or compressive stocking to guard against the development of PO-VTE. However, the results were discrepant, where Moussa and Mohamed found hemodilution at outset of surgery with LMWH therapy starting 12 hours after surgery in addition to the use of elastic stockings, provided significant reduction of the incidence of PO-VTE than elastic stocking alone.[11] On the contrary, Sjåvik et al. found no benefit of starting LMWH before IC meningioma surgery in terms of the incidence of PO-VTE and advised to reserve LMWH as needed in cases of delayed mobilization to guard against development of hemorrhagic events that may require second-look for hematoma evacuation.[18] Moreover, Fluss et al. found the rate of VTE for patients receiving LMWH or not is comparable.[13]

Coupling the reported incidence of PO-VTE to the controversy about the application of prophylactic LMWH therapies pointed to the necessity of finding preoperative predictors for the possibility of development of PO-VTE. The current study using ROC curve and regression statistical analyses showed that older age, higher BMI, smoking and presence of co-morbidities are the significant preoperative predictors, while patients' gender, ABO blood group and type of comorbidities, either cardiac or not, were not significant predictors for PO-VTE. Furthermore, statistical analyses suggested that surgery for recurrent lesion, long operative time and long PO ICU stay are significant predictors for oncoming PO-VTE. These predictors might act synergistically to increase the possibility of PO-VTE and multivariate regression analysis defined old patients undergoing surgery for recurrent IC lesion and recumbent for long duration in ICU, are more vulnerable to have PO-VTE especially if the patient was obese. Accordingly, the current study suggests that old age, recurrent IC lesion, and obesity with long recumbence in ICU, as early preoperative predictors for PO-VTE.

These findings are in accordance with those of Hoefnagelet al. who defined body weight and long duration of PO recumbency as the risk factors for VTE especially PE, but found tumor grade and VTE were not relevant.19 Also, Moussa and Mohamed found that old age, large tumor size, delayed ambulation after surgery and skull-base location of lesion were associated with high incidence of PO-VTE.11 Spinazzi et al. documented that patients who experienced PO-VTE were older, more commonly male and had longer hospitalizations, while Nunno et al. determined 5 risk factors for VTE including age ≥60 years, ASA grade III, long operative time, ventilator dependence, and preoperative transfusions.[12,20] In 2021,

Fluss et al. defined tumor volume, history of DVT, and length of hospital stay as independent risk factors for VTE while in 2022, Abunimer et al. documented that prior history of VTE, long anesthesia duration and blood transfusion were associated with significant risk ratio of VTE development.[13,15] Rizzo et al. identified history of VTE, obesity, and lack of pharmacologic prophylaxis as independent predictors of symptomatic VTE.[17]

The multiple risk factors suggested by these studies indicated that IC lesions per se are the main risk factor for development of PO-VTE and the suggested risk factors synergize this tendency. In line with this suggestion, a recent study detected significantly higher preoperative thrombin generation in patients with meningioma or glioblastoma in comparison to control levels, and these levels were higher in glioblastoma patients. There was significant decrease in peak thrombin generation after tumor excision, so it was concluded that systemic coagulation activation occurs with both meningioma and glioblastoma.[21] Moreover, previous studies suggested that tumor size, site of lesion especially skull-base lesions, and recurrent lesions as documented by the current study were risk factors for PO-VTE, and still assuring the suggestion that IC lesion per se is the main pathogenic factor for VTE development.[11,13]

As most previous studies in addition to the current study insisted on defining old age and obesity as risk factors, thus these factors might be considered as the main adjuvant risk factors for PO-VTE development and being of patients' constitutional factors, so could be used as early predictors for oncoming PO-VTE.

Heenkenda et al. suggested that B blood group is predictive for VTE incidence among glioblastoma patients. The present study showed higher frequency of patients of blood group B among the studied meningioma patients and among those who developed PO-VTE, but the difference was insignificant and statistical analyses excluded blood grouping as a predictor for PO-VTE.[22] In line with the current findings, the results obtained by Beynon et al. suggested a lack of relevance of the ABO-blood group type regarding VTE complications in meningioma resection patients.[23]

We recommend performing prospective wide-scale studies for evaluation of the incidence of PO-VTE after control of the modifiable risk factors, to determine the efficacy of this policy especially for patients with high risk for VTE.

CONCLUSION

Venous thromboembolic events are not a trivial complication of surgical excision of intracranial meningioma, unfortunately, the incidence of fatal pulmonary embolism is noteworthy. Some modifiable preoperative risk factors as obesity, smoking and uncontrolled chronic diseases were significant predictors for the possibility of development of PO-VTE especially in elderly patients and those who had recurrent IC lesion.

List Of Abbreviations

ANOVA: Analysis of variance.
ASA: American Society of Anesthesiology.
BMI: Body mass index.
CI: Confidence interval.
CT: Computerized tomography.
CVP: Central venous pressure.
DVT: Deep venous thrombosis.
IC: Intracranial.
ICU: Intensive care unit. IO: Intraoperative.
LMWH: Low molecular weight heparin.
LOS: Length of stay.
MRI: Magnetic resonance imaging.
PE: Pulmonary embolism.
PO: Postoperative.
PO-VTE: Postoperative venous thromboembolic events.
ROC: Receiver operating characteristic.
SD: Standard deviation.
SPSS: Statistical package for social sciences.
VTE: Venous thromboembolic events.
WHO: World Health Organization.

Recommendations

Prospective wide-scale studies for evaluation of the incidence of PO-VTE after control of the modifiable risk factors so as to determine the efficacy of this policy especially for patients with high risk for VTE.

Disclosure

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