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Value of Routine Preoperative Tests for Coagulation Before Elective Cranial Surgery. Results of an Institutional Audit and a Nationwide Survey of Neurosurgical Centers in Pakistan

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■ **BACKGROUND:** Routine preoperative blood testing has become a dogma. The general practice is to order preoperative workup as a knee-jerk response rather than individualize it for each patient. The fact that the bleeding brain tends to swell, which coupled with limited options for proximal control, packing, and overall hemostasis, leads to an overemphasis on the preoperative coagulation profile.

■ **MATERIAL AND METHODS:** This is a retrospective review of the medical records of patients admitted at Aga Khan University Hospital from January 2010 to December 2015 for an elective craniotomy. The hospital registry was used to identify files for review. Data were collected on a predefined proforma. A nationwide survey was performed, and 30 neurosurgery centers were contacted across Pakistan to confirm the practice of preoperative workup.

■ **RESULTS:** The survey revealed that all centers had a similar practice of preoperative workup. This included complete blood count, serum electrolytes, and coagulation profile, including prothrombin time, activated partial thromboplastin time (aPTT), and international normalized ratio (INR). A total of 1800 files were reviewed. Nine (0.5%) patients were found to have deranged clotting profile without any predictive history of clotting derangement; 56% were male and 44% were female. Median age was 32 years with an interquartile range of 27 years. Median aPTT was (40.8 with 20.8 IQR). Median INR was (1.59 with 0.48 IQR).

Median blood loss was (400 with 50 IQR). No significant association between coagulation profile (aPTT, INR) and blood loss was found ($P = 0.85$, $r = -0.07$).

■ **CONCLUSIONS:** We conclude that patients without a history of coagulopathy and normal physical examination do not require routine coagulation screening before elective craniotomy.

INTRODUCTION

It is common practice to assess preoperative coagulation parameters in patients scheduled to undergo elective cranial surgery. This is based on the notion that in cranial surgery, even small problems with intraoperative hemostasis, or even small postoperative hemorrhages, may have deleterious effects on patients' recovery and outcomes. The usefulness and cost-effectiveness of this widespread practice have not been questioned, other than a few studies.¹⁻⁴ Most coagulopathies in adult patients can be ruled out through a detailed history and a thorough examination, and routine coagulation studies may be excessive. Intraoperative and postoperative hemorrhages have been associated with a number of factors⁵⁻⁷; however, in patients without a known pre-existing coagulopathy, no association between preoperative coagulation studies as a predictor of intraoperative or postoperative hemorrhagic complications has been established. Similarly, the value of preoperative activated partial

Key words

- aPTT
- Blood loss
- Coagulopathy
- Craniotomy
- INR
- PT

Abbreviations and Acronyms

aPTT: Activated partial thromboplastin time

INR: International normalized ratio

IQR: Interquartile range

PT: Prothrombin time

USD: U.S dollar

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Table 1. Baseline Demographics of the Population

Demographics	n (%)
Sex	
Male	1006 (56%)
Female	794 (44%)
Median age, years	32
Comorbidities	
Hypertensive	233 (12.9%)
Diabetes	197 (10.9%)
Ischemic heart disease	42 (2.3%)
Cerebrovascular accident	27 (1.5%)
Chronic liver disease	16 (0.9%)
Chronic kidney disease	30 (1.7%)

thromboplastin time (aPTT) and international normalized ratio (INR) for predicting intraoperative and postoperative hemorrhages has remained elusive.⁸⁻¹⁵

The authors hypothesized that routine preoperative assessment of coagulation in patients undergoing elective craniotomy is nonessential and may be omitted in a certain patient population. We therefore performed a retrospective analysis of all patients who underwent elective craniotomy at our center to find out the utility of preoperative coagulation testing, the effect of abnormal coagulation on perioperative course, and the cost of this practice. As the second part of the study, we performed a nationwide survey of neurosurgical centers to find out the general practice in the country. Our aim was to find whether preoperative screening was helpful, and therefore needed, in predicting intraoperative and postoperative complications in those patients who did not have a known cause of coagulopathy.

METHODS

The study was conducted with approval from Surgery Departmental Review Committee and Hospital Ethics Review Committee at the Aga Khan University. It has been the practice at our institution that all patients planned for elective craniotomy undergo screening for coagulation abnormality in addition to the age-related routine laboratory tests. The laboratory tests performed for coagulation include prothrombin time (PT), aPTT, and INR; an aPTT >35 seconds or INR >1.4 are considered abnormal. Patients with an abnormal coagulation profile without a supportive history usually undergo repeat testing to rule out false positives, and those with a supportive history or abnormal coagulation on repeat testing are reviewed by our hematologist before surgery. Elective surgery under such circumstances is delayed temporarily or rescheduled entirely. In cases in which surgery cannot be delayed, it is undertaken under coverage of cross-matched blood products (fresh-frozen plasma, platelets, packed cells, etc.) that are dispensed as per requirement after mutual agreement between operating surgeon and anesthesiologist.

We retrospectively reviewed the medical records of all patients who underwent elective craniotomy at our institution from January

2010 till December 2015. A standardized pretested proforma was used to record relevant information from each patient's file, including radiologic and laboratory data and perioperative course. The value of routine preoperative coagulation testing was calculated by considering it as a screening test, the yield of the test being the number of patients tested to find out one true abnormality.¹⁶ The cost of preoperative coagulation profile was calculated from the existing hospital rates and the standard testing for each patient was calculated at U.S dollar (USD) 20.

The data were analyzed with SPSS, version 20 (IBM Corp., Armonk, New York, USA). Continuous variables of non-normal distribution were represented as median (interquartile range [IQR]). Categorical data were represented as percentages and proportions. Non-parametric tests were used to establish association (Spearman correlation), and scatter plots were used for statistical representation. The Mann–Whitney U test and Wilcoxon rank test were applied to establish the difference.

As the second part of the study, a telephone survey of senior neurosurgery residents and consultants working in different centers of Pakistan was conducted to identify the general practice of preoperative testing of patients scheduled for elective craniotomy (Appendix 1). The confidentiality of respondents and their institutions was maintained throughout.

RESULTS

Patient Demographics

A total of 1800 patients were included in the study. Of these, 56% were male and 44% were females. Median age was 32 years, with IQR of 27 and range of 18–70 years. Other details are shown in Table 1.

Value of Routine Preoperative Coagulation Testing

Of the 1800 patients, only 26 (1.4%) had elevated aPTT or INR on initial testing. Of these 26 patients, 17 (0.9%) already were expected to have a deranged coagulation profile based on their history alone (Table 2), and only 9 (0.5%) patients had an unexpected derangement of coagulation profile. In 2 of these 9 patients, the derangement was ignored on clinical grounds, as the anesthesiologist did not feel that these derangements warranted further evaluation, and the surgery was scheduled as planned. In the other 7 patients, the coagulation profile was

Table 2. Relevant History of Patients with Deranged Coagulation Profiles and Expected Coagulopathies

History	Number of Patients (n = 17)
Chronic liver disease	4
Warfarin only	7
Aspirin + warfarin	2
Clopidogrel + warfarin	2
Protein C, S deficiency	1
Aspirin + clopidogrel	1

Table 3. Demographics and Laboratory Derangements of Patients with Deranged Coagulation Profile, without Known Coagulopathy

No	Age, years	Sex	Pathology	Comorbidities	aPTT	INR	Repeat Test	Intraoperative Blood Loss, mL
1	25	M	Acoustic neuroma	None	54	1.63	Normal	400
2	25	M	Hemangioblastoma	None	32	1.76	Normal	400
3	29	F	Cerebral abscess	None	33	1.72	Normal	400
4	30	F	Meningioma	CVA	40	1.30	Not done	400
5	32	F	Acoustic neuroma	None	109	1.06	Normal	400
6	36	F	Meningioma	None	51	1.25	Not done	400
7	48	M	Meningioma	None	41	1.27	Normal	1300
8	60	M	GBM	None	120	4.25	Normal	300
9	70	M	A-comm aneurysm	HTN, IHD, CVA	31	1.59	Normal	250

aPTT, activated partial thromboplastin time; INR, international normalized ratio; M, male; F, female; CVA, cerebrovascular accident; GBM, glioblastoma multiforme; A-comm, anterior communicating artery; HTN, hypertension; IHD, ischemic heart disease.

repeated (causing additional cost and delay in surgery), which revealed a normal report, indicating a false-positive initial result. Of the other 17 patients who had expected abnormalities in coagulation profile, none had a false positive.

We further analyzed the 9 patients with deranged coagulation profiles and whether it affected their perioperative course. Three of these 5 were male, and the median age was 32 years (IQR 27 years). Median aPTT was 40.08 with an IQR of 20.8. Median blood loss was 400 mL with an IQR of 50 mL, which was not different from the mean blood loss of the rest of the patients ($P = 0.85$) (Table 3).

Cost of Testing

The cost of a single coagulation profile at our institution is Rs.2000 (USD 19.20). The total cost of testing for our sample of 1800 patients was Rs3.6 million (USD 34,615.40), and the total cost of tests that yielded results within normal limits in 1774 (98.6%) patients was Rs3.55 million (\$34,115.40 US).

Nationwide Survey of Neurosurgical Centers

The nationwide survey revealed that all the 30 neurosurgical centers contacted across Pakistan had a similar practice of

preoperative workup for patients undergoing elective craniotomy. This included the ordering of a complete blood count, serum electrolytes, and coagulation profile, including PT, aPTT, and INR for all patients scheduled for craniotomy. We also found that 22 of 30 (73.3%) centers contacted also routinely performed screening tests for hepatitis B and C (Table 4). Routine hepatitis B and C screening is not performed at our center or at most private centers. However, most government sector hospitals routinely perform screening because of the high prevalence of undetected hepatitis B and C in Pakistan.

DISCUSSION

The development of coagulation profile as a screening tool was subject to a high pretest probability in relation to patients with relevant medical history and physical findings of a coagulopathic condition. The use of such a test as a screening tool either fails in terms of cost-effectiveness or ends up with a low yield and thus carries limited utility. Therefore, there appears little reason to use it as a routine preoperative test.¹⁷ Rapaport¹⁸ described 4 levels of preoperative coagulation testing, depending on the history of the patient and the surgical procedure planned (Table 5). The American Society of Anesthesiologists in their practice advisory

Table 4. Nationwide Survey of Neurosurgical Centers and Their Preoperative Workup for Patients Undergoing Elective Craniotomy

Province	Number of Hospitals	CBC	PT, INR, aPTT	Electrolytes	Hepatitis (B, C)
Punjab	9	9	9	9	7
Sindh	8	8	8	8	5
Khyber Pakhtunkhwa	6	6	6	6	6
Balochistan	2	2	2	2	2
Islamabad	5	5	5	5	2
Total	30	30	30	30	22

CBC, complete blood count; PT, prothrombin time; INR, international normalized ratio; aPTT, activated partial thromboplastin time.

Table 5. Recommended Preoperative Screening Tests

Level 1	History is negative and surgery is minor	No screening tests is recommended
Level 2	History is negative and surgery is high risk	PTT and platelet count
Level 3	History is positive OR Surgery will impair hemostasis (cardiac surgery)	Platelet count, Bleeding time PTT, PT, fibrin clot analysis
Level 4	Screening history is suspicious and surgery is major or minor	Initial testing like level 3, If negative, then bleeding time with aspirin 600 mg, factor 8 and factor 9 activity,

PTT, partial thromboplastin time; PT, prothrombin time.

for preanesthesia evaluation have discouraged the routine use of preoperative coagulation profile and recommend identification of clinical characteristics to consider for subjecting patients to a selective coagulation profile. These include patients with a history of either congenital coagulopathy, acquired coagulopathy secondary to drug use (e.g., warfarin, aspirin, clopidogrel, and other anticoagulants), or a physical examination suggestive of coagulopathy. In addition, they recommend that already-available investigations may be used to assess the risk of bleeding.¹⁹

Similarly, the National Institute for Health and Care Excellence, United Kingdom, in their guidelines for preoperative evaluation, has also emphasized tailoring the preoperative testing on the basis of complete medical history and physical examination instead of relying on routine screening tests.²⁰

However, despite evidence stating otherwise, it is still common practice across the world, including our center and the 30 other neurosurgical centers in Pakistan we queried, to use these investigations as a screening test to detect coagulopathy in asymptomatic patients.¹⁻³ Our survey of major neurosurgical centers across Pakistan showed similar results to another survey conducted by Thiruvankatarajan et al.,²¹ who also concluded that preoperative screening tests of hemostasis and coagulation are still considered by many as a standard practice.

Our study shows that only 26 (1.4%) patients had elevated screening coagulation profiles, of whom only 9 (0.5%) had unanticipated elevations. Of these 9 patients, 7 (78%) had falsely elevated INR or aPTT, detected by repeating measurements, and the other 2 were not considered significant by the anesthesiologist. These findings were similar to Dützmann et al.,¹ who reported on the limited value of nonspecific preoperative PT testing. Of the 4310 patients included in the study, 78 (1.8%) had abnormal PT before the initial operation. Furthermore, only 5 patients (0.1%) were detected to have abnormal PT levels that were unanticipated as per medical, surgical, and drug history. Those 5 patients had a mean PT of 1.53 (range 1.37–1.74), which was considered as a safe value, as elaborated by Matevosyan et al.¹¹ Both studies showed that there were no patients who benefited from the screening tests in patients without suspected coagulopathy, based on history or physical examination. These findings support our hypothesis that preoperative screening in patients without a high pretest probability is not helpful.

In addition, of the 33 (0.8%) patients who did have hemorrhagic complications in the study of Dützmann et al., only 2 had elevated PT preoperatively. Both of these patients had attributable causes for this elevation. The average PT in this group was 1.09 (range 0.91–1.33), further supporting the case that PT values do not predict the probability of complications.

Seicean et al.² showed that approximately 58% of adult neurosurgery patients in United States undergo all 3 preoperative hemostasis screening tests. Kitchens,²² while commenting on the role of coagulation profile in preoperative period, also stated that routine preoperative coagulation tests are irrational and wasteful, as PTT may be prolonged for any of multiple reasons. It cannot serve and was not intended to serve as a hemostatic oracle. Using pretest probabilities, it serves very well as a screen for plasma-based hemostatic defects in patients who have a history of hemorrhage.

We could not calculate the yield of the coagulation profile as a screening test, as in our sample size of 1800 patients, the test failed to pick even a single new patient with coagulation abnormality. Our study clearly shows that routine use of this test offered no clinical benefit at all while adding substantially to the cost of managing the patient. In addition, most of the patients who had abnormal investigations had to go through repeat measurements that showed that the initial abnormality was a false positive in 7 of 9 (77.9%) of the cases and added the cost of an additional unnecessary investigation. Preoperative coagulation testing in elective neurosurgical cases, excluding patients with relevant history or anticoagulant use, is unnecessary unjustified and fails in cost-effectiveness. The cost estimation (USD \$34,115.40) does not take into account the cost of repeat testing, delay in surgery, the waste of resources, or the anxiety that it may have caused the patient and treating physicians. In a resource-limited setting, these investigations are even harder to justify. We would therefore recommend adopting a policy of “high risk” or “selective” screening instead of “mass” screening.¹⁶

CONCLUSIONS

Although a retrospective study design limits the strength of the argument, we conclude that patients without a relevant history and normal physical examination do not require routine coagulation screening before elective craniotomy.

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APPENDIX 1**QUESTIONNAIRE FOR NEUROSURGICAL CENTERS ACROSS THE COUNTRY**

1. Name of the center.

2. Location of center (province).

3. Do you perform routine preoperative labs before elective craniotomy?

Y/N

4. If Yes to Question 3, do these labs include screening for coagulation abnormalities?

Y/N

If Yes to Question 4, do these labs include?

i) PT/INR Y/N

ii) aPTT Y/N

iii) Platelet count Y/N

5. Does your center perform routine preoperative complete blood count testing?

Y/N

6. Does your center perform routine electrolyte testing?

Y/N

7. Does your center perform routine hepatitis B or C screening?

Y/N