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The effect of general anesthesia on hemostasis

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Abstract

Background: The growing number of surgical patients requiring long-term anticoagulation or presenting with coagulopathies necessitates a precise understanding of how anesthetic induction agents affect the hemostatic system.

Objective: To evaluate the acute impact of propofol and sufentanil induction on primary and secondary hemostasis using rotational thromboelastometry (ROTEM) and flow cytometry (FC).

Methods: A prospective pilot study was conducted on 7 adult patients (ASA physical status I) scheduled for elective surgery. Blood samples were collected immediately before and 5–7 minutes after intravenous induction with propofol and sufentanil (prior to surgical incision to exclude surgical trauma influence). Hemostatic parameters evaluated included ROTEM (EXTEM/INTEM: CT, CFT, Alpha angle, MCF, A10, A20) and FC (total and

activated platelet counts). Nonparametric paired data were analyzed using the Wilcoxon signed-rank test.

Results: A statistically significant increase in the EXTEM Alpha angle was observed post-induction ($p = 0.047$), indicating an accelerated rate of clot formation. A trend toward hypercoagulability was noted for EXTEM CFT ($p = 0.063$) and INTEM CT ($p = 0.108$). Other ROTEM parameters (MCF, A10, A20) showed no significant changes. Flow cytometry revealed less than a 5% difference in total and activated platelet counts ($p > 0.50$), indicating no clinically relevant alterantion of platelet function.

Conclusion: Induction of general anesthesia with propofol and sufentanil in ASA I patients exerts minimal influence on hemostasis, displaying only a slight trend toward hypercoagulability. Both agents can be safely administered without compromising perioperative coagulation dynamics.

Keywords: general anesthesia; propofol; sufentanil; hemostasis; rotational thromboelastometry; ROTEM; hypercoagulability; clot kinetics.

Introduction

The number of patients receiving anticoagulant therapy who undergo surgical procedures continues to increase. This includes patients following cardiac surgery with prosthetic valve replacement, patients with a history of pulmonary embolism (PE) or deep vein thrombosis (DVT), and, importantly, the growing elderly population whose medical conditions necessitate long-term anticoagulation therapy [1, 2]. In daily anesthetic practice, anesthesiologists frequently encounter patients treated with various anticoagulant agents, while in other cases anticoagulation is not administered despite clear clinical indications due to specific medical considerations. This dissertation presents, analyzes, and summarizes findings concerning changes in hemostasis observed during general anesthesia. A special category of patients includes individuals with inherited bleeding disorders and patients presenting with shock of various etiologies [3].

Hemostasis is defined as the physiological mechanism responsible for the cessation of bleeding following disruption of vascular integrity [1]. It represents a dynamic balance between procoagulant and anticoagulant processes. Disturbance of this balance may result either in hemorrhagic complications or, conversely, in excessive coagulation and thrombus formation. The primary trigger of hemostasis is injury to the vascular endothelium, which facilitates contact between circulating blood elements and thrombogenic extravascular tissues.

The hemostatic process comprises:

- Primary hemostasis, involving platelets and the vessel wall, leading to the formation of the primary platelet plug.
- Secondary hemostasis, involving plasma coagulation factors and their inhibitors, culminating in the formation of a stable fibrin clot.

Subsequently, fibrinolysis occurs, representing the physiological process responsible for thrombus dissolution.

The most commonly used anesthetic agents for induction of anesthesia today are propofol and sufentanil (SFNT). Their effects on hemostasis were therefore evaluated in this study [1, 4, 5].

Objective

The purpose of this study was to determine the effect of general anesthesia (specifically induction with propofol and sufentanil) on hemostasis and to identify which method of anesthesia should be preferred by anesthesiologists to ensure maximum patient safety during elective or emergency surgery.

Materials and Methods

In this study, rotational thromboelastometry (ROTEM) and flow cytometry (FC) were used to assess coagulation changes induced by anesthetics (propofol and SFNT) in seven ASA I adults. Blood samples were collected before and 5-7 minutes after anesthetic administration, prior to surgical incision, minimizing surgical trauma influence.

Thromboelastometry (ROTEM) is a diagnostic method that evaluates coagulation by assessing the integrations of coagulation factors, inhibitors, anticoagulants and blood cells, particularly platelets, during clot formation and fibrinolysis. ROTEM employs two primary assays – EXTEM and INTEM – and three supplementary assays – FIB-TEM, AP-TEM and HEP-TEM – for different diagnosis [6, 7]. EXTEM and INTEM analyses included clotting time (CT), clot formation time (CFT), alpha angle and maximum clot firmness (MCF).

Flow cytometry (FC) allows quantitative and qualitative analysis of platelets and other blood particles [4]. In this study, FC measured total and activated platelet counts.

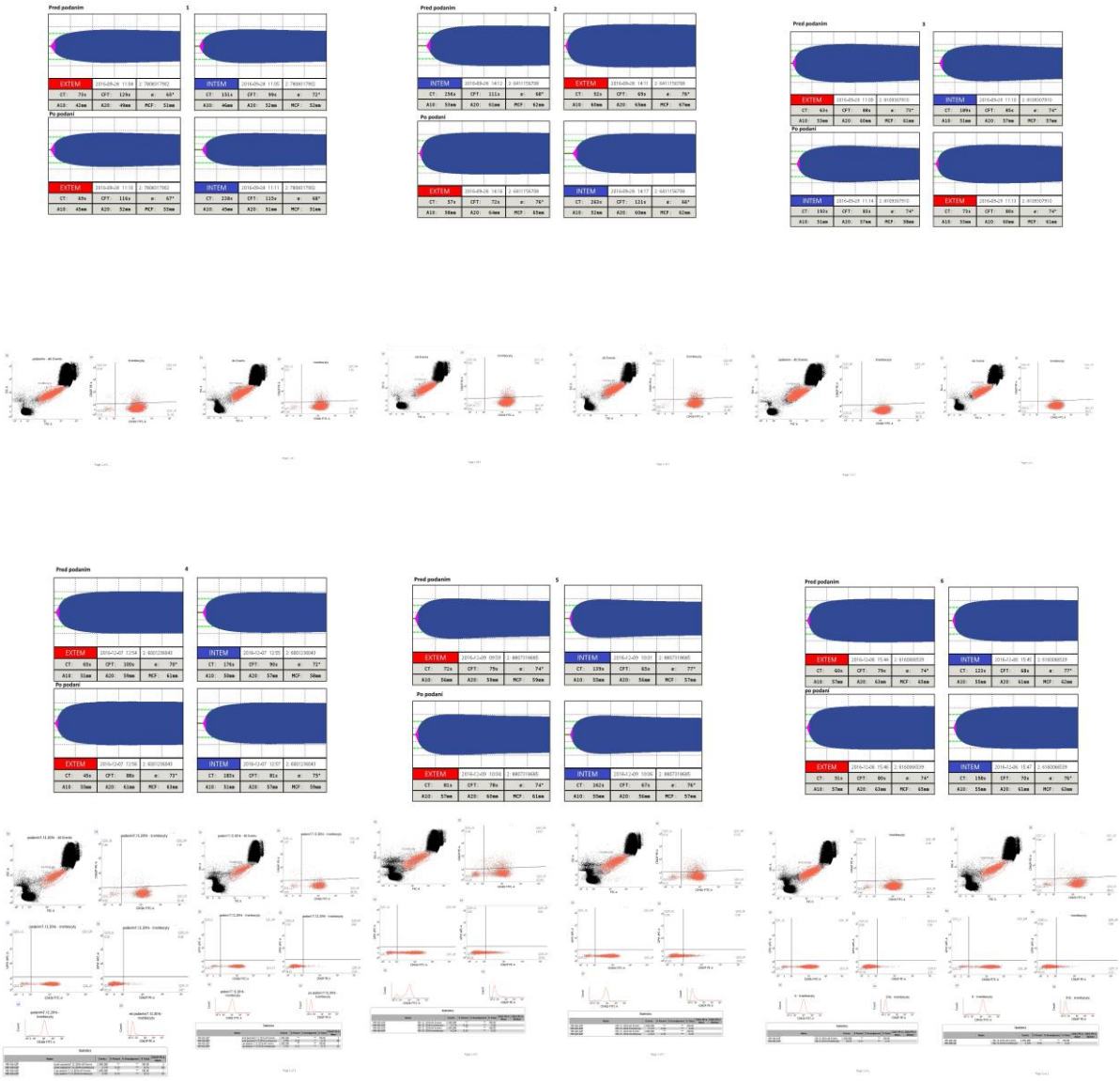
Statistical analysis was performed using the Wilcoxon paired nonparametric test.

Results

The alpha angle in the EXTEM assay increased significantly after administration of propofol and sufentanil, suggesting accelerated clot formation. CFT approached statistical significance, indicating a trend toward hypercoagulability.

INTEM clotting time (CT) also approached statistical significance, consistent with a trend toward hypercoagulability. Other ROTEM parameters, including MCF , did not show significant changes.

FC analysis revealed less than a 5% difference in both total platelet count and activated platelet count after anesthetic administration, indicating no clinically relevant effect on platelet function. (Figure 1)



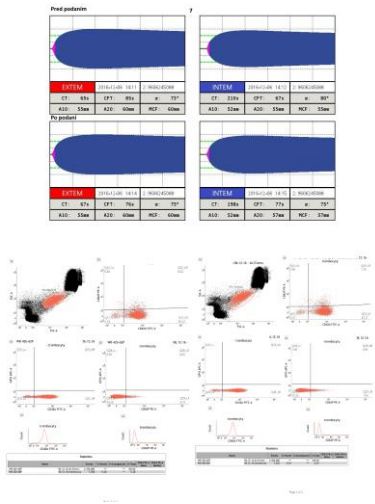


Figure 1. Composite graphical representation of thromboelastometry (ROTEM) and flow cytometry (FC) analyses for the study participants (n=7). Each numbered panel corresponds to an individual patient (ASA I). The upper sections of each panel display ROTEM traces for EXTEM (left) and INTEM (right) assays, recorded before (*Pred podaním*) and 5–7 minutes after (*Po podaní*) the induction of general anesthesia with propofol and sufentanil. These traces illustrate the kinetics of clot formation (CT, CFT, Alpha angle) and maximum clot firmness (MCF). The lower sections of each panel present the corresponding flow cytometric scatter plots, depicting the quantitative and qualitative analysis of total and activated platelet populations at the same time points.

A paired Wilcoxon signed-rank test revealed no statistically significant difference between baseline and post-intervention values (V = 3, p = 1.000)

Summary of results:

- PC all events: population medians not statistically significantly different; p-value = 0.5839
- PC trb: population medians not statistically significantly different; p-value = 1
- PC percent: population medians not statistically significantly different; p-value = 0.6996
- PC trba: population medians not statistically significantly different; p-value = 0.5625
- CT Extem: population medians not statistically significantly different; p-value = 1
- CT Intem: population medians not statistically significantly different; p-value = 0.1077. Note: the p-value borderlines the weak significance; p close to 0.1.

- CFT Extem: population medians not statistically significantly different; p-value = 0.06316. Note: the pvalue borders on the significance; p close to 0.05.
- CFT Intem: population medians not statistically significantly different; p-value = 0.2424
- alpha Extem: population medians ARE statistically significantly different; p-value = 0.04725
- alpha Intem: population medians not statistically significantly different; p-value = 0.2017
- MCF Extem: population medians not statistically significantly different; p-value = 0.3559
- MCF Intem: population medians not statistically significantly different; p-value = 0.1723
- A10 Extem: population medians not statistically significantly different; p-value = 0.3078
- A10 Intem: population medians not statistically significantly different; p-value = 0.6036
- A20 Extem: population medians not statistically significantly different; p-value = 0.2199
- A20 Intem: population medians not statistically significantly different; p-value = 1
- For alpha Extem there is statistically significantly different population median before and after treatment. We can say even more: the population median alpha Extem before is statistically significantly lower than after; pvalue = 0.04725/2 = 0.023625. The one-sided 95% confidence interval is (-Inf, -0.250507).
- For CFT Extem the population medians are weakly significantly different; pvalue 0.06316.
- For CT Intem the difference of population medians before and after is close to weak significance; pvalue 0.1077.

Discussion

The primary objective of this study was to evaluate the acute effects of induction with propofol and sufentanil on hemostasis. Our findings demonstrate that this anesthetic regimen in healthy (ASA I) patients produces a mild, non-pathological trend toward

hypercoagulability, evidenced by a statistically significant increase in the EXTEM Alpha angle ($p = 0.047$) and a borderline shortening of EXTEM CFT ($p = 0.063$).

These results align with previous observations regarding intravenous anesthetics. For instance, Koo et al. investigated the influence of propofol using rotational thromboelastometry and reported comparable subtle alterations in coagulation dynamics. The observed hypercoagulable shift following propofol administration is often attributed to its lipid emulsion vehicle, which may provide a procoagulant surface favoring the activation of clotting factors, rather than a direct effect of the active molecule itself.

Importantly, our flow cytometry analysis revealed no significant impairment or overactivation of platelets (differences < 5%). As highlighted by Faraday, preserving platelet function during the perioperative period is crucial for minimizing bleeding complications. The combination of propofol and sufentanil appears to leave primary hemostasis entirely intact.

While standard plasma-based coagulation tests (PT, aPTT) often fail to detect subtle kinetic changes in clot formation, viscoelastic tests like ROTEM provide a comprehensive, real-time assessment of whole-blood coagulation. As demonstrated by Schochl et al. and Nakayama et al., ROTEM is highly sensitive to dynamic shifts in hemostasis, which allowed us to detect the slight acceleration in clot firmness represented by the Alpha angle.

Clinical Implications: For ASA I patients, the minor hypercoagulable trend observed is clinically insignificant and confirms the safety profile of propofol and sufentanil. However, as noted in our introduction, the modern surgical population increasingly includes elderly patients and individuals with a history of deep vein thrombosis (DVT) or pulmonary embolism (PE). In such vulnerable cohorts, even minor procoagulant shifts during anesthetic induction might warrant closer monitoring.

Conclusion

Based on the results of this study, the use of propofol or sufentanil for induction of general anesthesia in ASA I adult patients produced minimal effects on coagulation, with only a slight trend toward hypercoagulability observed in some ROTEM parameters. These results suggest that both agents can be safely used in clinical practice without significant impact on hemostasis.

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