

INTRODUCTION: Newborns are characterized by numerous differences in hemostasis in comparison with adults, which results in this group of patients being at high risk of severe bleeding, e.g., intracranial. This problem mainly concerns premature babies. It should be emphasized that it is well documented that newborns have a lower concentration of plasma coagulation factors, equal to approximately 50% of the values recorded in adults. The functional assessment of hemostasis in these patients is still a challenge. In the literature, there are only a few studies on this topic, and the material studied is mainly umbilical cord blood, which is more available. Routinely used basic tests assessing blood coagulation efficiency have a number of limitations in the case of newborns, such as the time of execution, problems with blood collection, or the larger amount of blood needed to obtain plasma. Thromboelastometry is a method that allows for a comprehensive assessment of hemostasis, both in terms of primary and secondary hemostasis, as well as fibrinolytic activity.

AIM OF THE STUDY: The aim of the study was to assess the process of hemostasis in the peripheral blood of newborns born between the 28th and 41st week of pregnancy using thromboelastometry, as well as identification of factors influencing the course of hemostasis in newborns depending on anthropometric features such as gestational age, sex, birth weight, expected birth weight and clinical features such as route of delivery, APGAR score, maternal health problems (gestational diabetes, hypothyroidism, hypertension). An attempt was also made to determine the influence of hsCRP concentration and platelet parameters such as platelet count and MPV on the tested thromboelastometric parameters.

MATERIALS AND METHODS: The study group included 60 newborns, 25 boys and 35 girls. The pregnancy was terminated by natural delivery in 26 newborns and by cesarean section in 34 newborns. APGAR score at 1 minute was between 8 and 10 points in 50 newborns and below 8 points in 10 newborns. The basic criterion for inclusion in the study was the lack of clinical signs of hemostatic disorders. The exclusion criteria were chromosomal aberrations, organic congenital defects, and hypotrophy below the 3rd percentile. To conduct the research, consent was obtained from the Bioethics Committee of the Nicolaus Copernicus University in Toruń at the Collegium Medicum in Bydgoszcz nr KB 350/2020. The material for the study consisted of peripheral venous blood collected with an anticoagulant of 3.2% sodium citrate in the first 48 hours of the newborn's life,

remaining after carrying out other necessary and standard laboratory tests, in accordance with applicable standards of neonatal care. Thromboelastometry was performed within three hours from blood collection. The parameters tested as part of the study within the EXTEM, INTEM, FIBTEM tests: Coagulation Time (CT), Clot Formation Time (CFT), α -Angle, (α), Amplitude (Firmness) at time 5, 10, 20 minutes (appropriately A5, A10, A20), Maximum Clot Firmness (MCF) and Maximum Lysis (ML) were determined in accordance with the manufacturer's recommendations at the Department of Pathophysiology, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń. Additionally, CRP concentration was tested, determined by a highly sensitive immunoturbidimetric method based on the phenomenon of immunological agglutination using COBAS c311 and c501/502 analyzers in Roche/Hitachi COBAS c systems, and platelet parameters (PLT, MPV), which were determined in hematology analyzers using the impedance method at the Department of Laboratory Diagnostics at the University Hospital No. 2 in Bydgoszcz.

RESULTS: Our research showed a significant impact of the route of delivery and the number of platelets on thromboelastometric parameters. Among the EXTEM parameters, neonates born by cesarean section had significantly higher results for the A20 and MCF (appropriately A20 58 mm vs. 52,5 mm, $p = 0,049$ and MCF 59 vs. 53,5, $p = 0,046$) parameters, which indicates greater cohesion and clot stability, compared to newborns born through the natural route. The process of forming a stable clot, expressed as the INTEM CFT parameter, and its kinetics, which are characterized by the alpha angle, are greater and occur faster over time in neonates born by cesarean section than in neonates born through the natural route (appropriately CFT 86 s vs. 128 s, $p = 0,011$ and α -Angle 72,5 vs. 65,5, $p = 0,013$). Newborns born by cesarean section had a significantly lower FIBTEM ML score compared to newborns born naturally (appropriately 0,0 s vs. 2,0; $p = 0,038$), which may indicate a slower activation of the fibrinolysis process in the group of newborns born by cesarean section. Additionally, it was also found that in newborns born before the 37th week of pregnancy, activation of fibrinolysis is faster compared to newborns born between 37th and 41st weeks of pregnancy (Me = 18,00% vs. 9,00%, $p = 0,007$). In newborns with higher birth weight, increased extrinsic clot cohesion (EXTEM) was observed, expressed by the A5, A10, A20 and MCF parameters appropriately EXTEM A5 ($R = 0,269$, $p = 0,037$), EXTEM A10

(R = 0,290, p = 0,024), EXTEM A20 (R = 0,307, p = 0,017) and EXTEM MCF (R = 0,342, p = 0,007). However, there was no influence on thromboelastometric parameters of factors such as the APGAR score in the first minute of life or maternal health problems.

CONCLUSIONS: Gestational age did not significantly affect the kinetics of clot formation and its cohesion, however, in newborns born before the 37th week of pregnancy, faster activation of the fibrinolytic system was observed compared to full-term newborns. An influence of female gender on faster clot retraction and liquefaction was observed, but only in terms of the INTEM parameter, as well as an influence of higher birth weight on the dynamics of clot formation in terms of the EXTEM parameter. This observation was not confirmed in relation to the calculated expected birth weight. A significant influence of the route of delivery on the process of clot formation, cohesion and stability has been demonstrated. The mechanism of coagulation activation occurred faster and more effectively in newborns born by cesarean section compared to natural delivery. In the thromboelastometry study, there was no significant effect of CRP concentration on hemostasis. Univariate and multivariate regression analysis confirmed a significant impact of two key factors, the route of delivery and the number of platelets, on the process of activation of coagulation and the formation of a stable clot. Studies have shown that in order to comprehensively assess hemostasis, three basic EXTEM, INTEM and FIBTEM tests should be performed simultaneously because some of the mechanisms revealed in the study depend on the route of coagulation activation.

Keywords: Thromboelastometry, ROTEM, Newborn, Hemostasis, Platelets.

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