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# Assessment Of The Blood Coagulation System Using Optical Coagulometry In The Laboratory

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## Abstract

The blood coagulation system plays a fundamental role in maintaining hemostasis and preventing excessive blood loss following vascular injury. Accurate laboratory assessment of coagulation parameters is essential for diagnosing bleeding disorders, thrombotic diseases, liver dysfunction, and monitoring anticoagulant therapy. Optical coagulometry is one of the most widely used automated methods for evaluating plasma coagulation because of its high analytical sensitivity, precision, and rapid turnaround time. The present study aimed to evaluate the coagulation system of healthy volunteers using optical coagulometry by determining Prothrombin Time (PT), Activated Partial Thromboplastin Time (APTT), and fibrinogen concentration. Venous blood samples were collected into 3.2% sodium citrate tubes, centrifuged to obtain platelet-poor plasma, and analyzed using the Sysmex CA-1500 optical coagulometer. The obtained results demonstrated PT, APTT, and fibrinogen values within the established reference intervals, confirming normal hemostatic function in healthy individuals. The study also discusses the analytical advantages, diagnostic significance, and limitations of optical coagulometry in routine clinical laboratory practice.

**Keywords:** Optical coagulometry, blood coagulation, hemostasis, Prothrombin Time, Activated Partial Thromboplastin Time, fibrinogen, coagulation factors, plasma.

## Introduction

Hemostasis is a highly regulated physiological process responsible for maintaining blood fluidity under normal conditions while rapidly forming a clot following vascular injury. It involves a complex interaction among blood vessels, platelets, plasma coagulation factors, anticoagulant proteins, and the fibrinolytic system. Disruption of any component of this process may result in either excessive bleeding or pathological thrombosis.

The coagulation cascade consists of intrinsic, extrinsic, and common pathways that ultimately lead to the conversion of soluble fibrinogen into insoluble fibrin, forming a stable blood clot. Laboratory evaluation of coagulation is therefore essential in clinical medicine for diagnosing inherited and acquired coagulation disorders, liver diseases, disseminated intravascular coagulation (DIC), cardiovascular diseases, diabetes mellitus, severe infections including sepsis, and for monitoring anticoagulant therapy. Among laboratory techniques, optical coagulometry has become one of the most reliable and frequently applied automated methods. This technique measures changes in plasma optical density as fibrin clot formation occurs after activation of the coagulation cascade by specific reagents. Compared with traditional manual clotting assays, optical coagulometry provides greater precision, improved reproducibility, reduced operator dependency, and faster processing of large numbers of samples.

The most commonly performed coagulation tests include: Prothrombin Time (PT), evaluating the extrinsic and common coagulation pathways. Activated Partial Thromboplastin Time (APTT), assessing the intrinsic and common pathways. Fibrinogen concentration, reflecting the availability of the major substrate required for fibrin clot formation. These parameters provide valuable information regarding coagulation factor deficiencies, liver synthetic function, vitamin K status, anticoagulant therapy, and inflammatory conditions.

Aim of the Study:The objective of this study was to evaluate the blood coagulation system of healthy volunteers using the optical coagulometry method by determining PT, APTT, and fibrinogen concentration and comparing the obtained values with internationally accepted reference ranges.

Materials and Methods:

Study Design

A descriptive laboratory-based observational study was conducted on healthy adult volunteers without a history of bleeding disorders, thrombotic disease, anticoagulant therapy, or chronic liver disease.

Sample Collection

Venous blood was collected under aseptic conditions into vacuum tubes containing 3.2% sodium citrate at a blood-to-anticoagulant ratio of 9:1. Immediately after collection, samples were gently inverted several times to ensure complete mixing with the anticoagulant.

The samples were centrifuged at 3000 rpm for 10 minutes to obtain platelet-poor plasma. The separated plasma was carefully transferred into clean polypropylene tubes and analyzed immediately.

Equipment

Optical Coagulometer: Sysmex CA-1500

Fully automated optical clot detection system

Reagents

-PT reagent containing thromboplastin and calcium chloride

-APTT reagent

-Fibrinogen reagent (Clauss method)

-Quality control plasma

-Calibration plasma

-Principle of Optical Coagulometry

Optical coagulometry detects clot formation by measuring changes in light transmission through plasma. Initially, plasma remains transparent, allowing maximum light transmission. Following activation of coagulation by the addition of specific reagents, fibrin polymers begin to form, increasing plasma turbidity. The instrument continuously monitors changes in optical density until clot formation is completed, automatically calculating coagulation time.

Laboratory Procedure

All reagents and plasma samples were equilibrated to 37°C before analysis.

PT Test

Thromboplastin reagent containing calcium ions was added to citrated plasma. The instrument measured clot formation time automatically.

APTT Test

Plasma was incubated with APTT reagent followed by calcium chloride. Clotting time was automatically recorded.

Fibrinogen Assay

Fibrinogen concentration was measured using the Clauss method based on thrombin-induced clot formation.

Statistical Analysis

Descriptive statistical analysis was performed. Measured values were compared with internationally accepted reference intervals for healthy adults.

## Results

The obtained laboratory results demonstrated normal coagulation function in all analyzed samples.

Table 1. Optical Coagulometry Results

| Parameter | Measured Value | Reference Range | Interpretation |
|---|---|---|---|
| PT | 12.5 s | 11–14 s | Normal |
| APTT | 31.8 s | 25–35 s | Normal |
| Fibrinogen | 2.8 g/L | 2.0–4.0 g/L | Normal |

The PT value indicated normal function of coagulation factors I, II, V, VII, and X within the extrinsic pathway.

The APTT result demonstrated normal activity of intrinsic coagulation factors VIII, IX, XI, XII, prekallikrein, and high molecular weight kininogen.

Fibrinogen concentration remained within physiological limits, indicating adequate hepatic synthesis and normal clot substrate availability.

Overall, the laboratory findings confirmed intact hemostatic function in the examined healthy volunteers.

## Discussion

Optical coagulometry has become the standard method in many clinical laboratories due to its high analytical accuracy and automation. Compared with manual coagulation techniques, optical detection significantly reduces operator-related variability while increasing reproducibility.

PT remains the primary screening test for evaluating vitamin K-dependent coagulation factors and monitoring warfarin therapy. APTT is

indispensable for detecting intrinsic pathway abnormalities and monitoring unfractionated heparin treatment.

The fibrinogen assay provides clinically important information regarding inflammatory diseases, liver dysfunction, disseminated intravascular coagulation, trauma, pregnancy, and cardiovascular disorders.

The normal PT, APTT, and fibrinogen values observed in this study are consistent with previously published reference data reported by the International Society on Thrombosis and Haemostasis (ISTH) and the Clinical and Laboratory Standards Institute (CLSI).

Despite its advantages, optical coagulometry possesses several limitations. Hyperlipemic, icteric, or hemolyzed plasma samples may interfere with light transmission and produce inaccurate clot detection. Extremely high fibrinogen concentrations, paraproteinemia, or severe hyperbilirubinemia may also affect analytical performance.

Modern coagulometers incorporate automatic quality control procedures and calibration systems that significantly improve analytical reliability.

Because of its rapid processing speed, minimal operator intervention, and excellent precision, optical coagulometry is highly suitable for routine clinical laboratories, emergency departments, intensive care units, and specialized hematology centers.

-Advantages of Optical Coagulometry

-High analytical sensitivity

-Excellent precision and reproducibility

-Fully automated operation

-Rapid turnaround time

-Minimal operator-dependent variability

-Suitable for high-throughput laboratories

-Reliable quality control systems

-Broad clinical applicability

-Limitations

-Interference by hemolyzed plasma

-Lipemic samples may produce false results

-Hyperbilirubinemia affects optical measurements

-Requires routine calibration

-High equipment and reagent costs

-Clinical Applications

-Optical coagulometry is routinely used for:

-Diagnosis of congenital coagulation disorders
-Evaluation of acquired bleeding disorders
-Monitoring anticoagulant therapy
-Liver disease assessment
-Detection of disseminated intravascular coagulation (DIC)
-Preoperative coagulation screening
-Cardiovascular disease management
-Critical care laboratory testing

**Conclusion**

Optical coagulometry is a highly reliable, sensitive, and automated laboratory technique for evaluating blood coagulation. The present study demonstrated that PT, APTT, and fibrinogen values obtained from healthy volunteers were all within normal reference ranges, confirming normal hemostatic function. The method offers significant analytical advantages, including rapid analysis, high precision, and minimal operator dependence, making it an indispensable tool in modern clinical laboratories. Nevertheless, careful attention should be paid to pre-analytical variables and plasma quality to avoid analytical interference. Future studies involving larger sample sizes and patients with coagulation disorders will further strengthen the clinical utility of optical coagulometry.

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