Journal of Engineering Physics and Thermophysics, Vol. 69, No. 3, 1996

THE HEMORHEOLOGICAL BASIS OF TRANSFUSION THERAPY IN THE CASE OF EXTRAUTERINE PREGNANCY

T. A. Smirnova, G. I. Gerasimovich, and G. M. Kostin

UDC 618.31-07:615.38

The authors have studied 122 medical histories of extrauterine pregnancies from archives and directly followed up 122 patients who underwent emergency surgery for extrauterine pregnancy. Particular disturbances of rheological properties of blood in patients with ectopic pregnancy are revealed. The authors prove the necessity of rheologically active infusion-transfusion therapy, which normalizes rheological properties of blood, its acidic and basic conditions, and protein composition both during the operation and in the postoperational period. The following solutions were used: acesol, Haemodesum, rheopolyglucine, rheoglumane, gelatinol, 10% albumin solution, and fresh frozen plasma.

These studies were carried out to investigate rheological properties of blood in patients with extrauterine pregnancy in order to compose scientifically justified therapeutic infusion-transfusion schemes.

This problem is very urgent because at present the extrauterine pregnancy is showing a rate tendency to increase, and constitutes 1 per 60 births [1-4]. According to many authors, the extrauterine pregnancy rate has doubled or tripled in recent decade [5-10]. The importance of the problem is also caused by a high level of postoperative complications such as anemia, complications of the operative wound, and infiltrations in the true pelvis, which promote the development of commissures and secondary infertility in patients of this category.

In view of the fact that the cause of these complications is surgery-induced disturbances of blood microcirculation, our attention was drawn to rheological properties of blood, which is one of the leading factors in microcirculatory disturbances.

Objectives of the present study were as follows:

1. To analyze results of surgical treatment of patients with extrauterine pregnancy, depending on the amount of surgery.

2. To investigate rheological properties of blood in such patients before operation depending on the amount of blood loss, duration of the disease, and presence of associated genital or extragenital pathology.

3. To investigate changes in rheological properties of blood and clinical conditions of the patients immediately after surgery and in dynamics of the postoperative period, depending on infusion-transfusion fluids used.

4. Taking into account the resulting data, to develop optimal scientifically justified tactics of infusion-transfusion therapy during the surgery and in the postoperative period for rehabilitation of this category of patients and to decrease the level of postoperative complications.

We studied 122 medical histories of patients with extrauterine pregnancy from archives and also followed up 122 patients who underwent emergency surgery for extrauterine pregnancy in the Gynecology Department of Clinical Hospitals No. 2 and 7 and in the Acute Hospital of Minsk.

All the patients were subjected to clinical and laboratory investigations before the operation and in the postoperative period.

Special investigations were carried out additionally: determination of the blood loss volume, studies of rheological properties of blood, acidic-basic conditions, coagulation system, and electrolytical and protein blood

Minsk State Medical Institute, Minsk, Belarus. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 69 No. 3, pp. 456-459, May-June, 1996. Original article submitted March 20, 1996.

 1062-0125/96/6903-0364$15.00

composition. Hematological characteristics were also studied. The above investigations were carried out before operation, immediately after it, on days 1, 2, 3, 5, and 7 after the operation, and before discharge.

Blood viscosimetry was performed in a rotary viscosimeter of V. N. Zakharchenko's design. Erythrocyte deformability was measured with a method modified by G. M. Kostin [11].

For assessment of the rheological efficiency, the following infusion fluids were used selectively: acesol, rheoglumane, rheopolyglucine, Haemodesum, gelatinol, 10% albumin solution, and fresh frozen plasma. These solutions were used both during operation and as an addition to the conventional transfusion therapy, and rheoglumane, rheopolyglycine, Haemodesum, and gelatinol were administered during the operation and for three days after it. The fluids were transfused four times, 400– 800 ml each time; acesol infusions were made at a dose of 800–1200 ml four times. Fresh frozen plasma and a 10% albumin solution were transfused at the same time intervals but in smaller volumes: 200–300 ml of plasma and 100–200 ml of 10% albumin solution per transfusion.

Conventional transfusions of donor blood or concentrated red cells, glucose solution, isotonic sodium chloride solution, physiological salt solution, and polyglucine were administered to 25 patients. This group was a control for assessment of the efficiency of the influsion fluids enumerated above. Moreover, 16 normal women constituted a control group for estimation of rheological properties of blood.

Analysis of the archive material showed a high level of postoperative complications (49%) in patients with extrauterine pregnancy who were treated with conventional transfusion methods.

In 41% of patients with ectopic pregnancy who were directly followed up by the present authors, various infectious diseases were found in past history. Associated gynecological pathology was diagnosed in 78.6% of the patients.

Results of the study of rheological properties of blood in our patients investigated at admission show that they had blood microcirculation disturbances and in these patients the erythrocyte aggregation index and the yield point were almost twice as high as the control norms. Apparent ($p < 0.05$) and internal apparent ($p < 0.05$) viscosities were increased substantially in comparison with the control group. Investigation of erythrocytes carried out in the total group of patients showed their higher rigidity as compared with the control group.

Thorough analysis showed that the total group of the pateints was inhomogeneous in rheological properties of blood, and this trait was used as a basis for division of the patients into two subgroups: subgroup I: 57 (53.8%) patients who had rheological disturbances due to enhanced static aggregation of erythrocytes; subgroup II: 49 (46.2%) patients who did not have disturbances due to static erythrocyte aggregation. An increase in the caisson viscosity and internal caisson viscosity (its dimensional counterpart) is a significant factor in this subgroup of the patients.

In general, in the patients investigated conditions of compensated metabolic acidosis and hypercoagulation were observed. These factors can be a reason for rheological disturbances.

When colloid blood expanders were used in addition to the conventional infusion fluids, it was determined that Haemodesim was fully ineffective both during operation and in the entire postoperative period.

Gelatinol infusions had a pronounced rheological effect for three days after the operation, i.e., at the time of administration. Rheopolyglucine infusions did not have the expected profound effect on rheological properties of blood. Rheoglumane infusions had a phase rheological effect. The peak antiaggregation effect of the medicine was observed on days 1, 2 and 5–7 after the operation.

A higher rheological efficiency was found in the case of natural colloids – fresh frozen plasma and albumin. Fresh frozen plasma transfusions actually normalized both static erythrocyte aggregation and apparent viscosity of blood, but the peak of their activity was observed on day 5 after the operation. The rheological effect of fresh frozen plasma transfusions can be attributed to stable elimination of protein imbalance.

Albumin transfusions pronouncedly normalized rheological properties of blood during operation, however, in the postoperative period they only maintained the rheological characteristics at a preoperative level.

Acesol infusions did not show any beneficial effect on either acidic-basic characteristics of blood or its rheological properties.

Comparative analysis of the blood expanders used allowed us to isolate the four most rheologically active fluids, which can be recommended as an addition to conventional fluids used in infusion therapy for treatment of

patients with extrauterine pregnancy. These are fresh frozen plasma, 10% albumin solution, rheoglumane, and rheopolyglucine. Moreover, the present results suggest that infusion-transfusion therapy with these fluids should be administered for a longer period than the first day after operation, i.e., up to discharge.

Such rheological efficiency of infusions has a direct effect on the clinical course of the postoperative period.

In this category of patients the postoperative hospital stay decreased to 10.59 ± 0.19 ($p < 0.001$) in comparison with the group of patients treated by the conventional transfusion therapy (11.52 ± 0.2).

CONCLUSIONS

1. Treatment of patients with extrauterine pregnancy with conventional transfusion therapy (donor blood or concentrated red cells, 5% glucose solution, isotonic sodium chloride solution, physiological salt solution, and polyglucine) is only slightly effective as regards rheological properties of blood and is associated with complications in 49% of patients.

2. Studies of rheological properties of blood in patients with extrauterine pregnancy before operation have shown that 53.8% of the women had pronounced disturbances induced by enhanced erythrocyte aggregation.

3. Administration of intense infusion-transfusion therapy during operation and in the postoperative period results in a decrease of the average bed-day for this category of patients to (10.59 ± 0.19) in comparison with the conventional transfusion therapy (11.52 ± 0.2). The number of postoperative complications was 60% lower as compared with the group of patients from the archives (19.7% against 49%).

REFERENCES

1. S. G. Safina, A. A. Khairullina, M. M. Shakurova, et al., Nauch. Trudy Kazan Med. Inst., **51**, 58-64 (1978).
2. G. I. Gerasimovich, T. N. Kolgushkina, P. P. Serdyuk, and L. A. Zhukovskaya, Zdravookhranenie Belorussii, No. 5, 54-57 (1985).
3. D. Boulieu, P. Lambert, and D. Randrant, Rev. French. Gynecol. Obstet., **81**, No. 11, 597-607 (1985).
4. J. Coste and N. Job-Surra, J. Gynecol. Obstet. Biol. Reprod., **17**, No. 8, 991-1001 (1988).
5. R. Gadda, M. O. Scerif, R. Carcione, et al., Minerva Gynecol., **36**, No. 5, 227-232 (1984).
6. M. Gummerus, A. Saari-Kemppainen, Zentralbl. Gynäkol., **108**, No. 2, 112-117 (1986).
7. F. D. Loffer, J. Reprod. Med., **31**, No. 2, 173-180 (1986).
8. S. F. Dorfman, Clin. Obstet. Gynecol., **30**, No. 1, 173-180 (1987).
9. L. G. Gorodeski, Ch. M. Bahary, Eur. J. Obstet. Gynecol., **24**, No. 1, 57-62 (1987).
10. G. M. Flett, D. R. Urauhart, C. Fraser, et al., Br. J. Obstet. Gynaecol., 95, No. 8, 740-746 (1988).
11. G. M. Kostin, A Method for Determination of Erythrocyte Deformability by a TsLK-1 or TsLK-3 Centrifuge [in Russian], Innovation No. 984 adopted by Belarusian Blood Transfusion Inst., Apr. 04.24.1981.