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Analysis of risk factors and assessment of prevention of venous thromboembolic complications in patients with hip joint replacement

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The issue of thromboembolic complications prevention is one of great importance, since patients have a high risk of developing postoperative venous thromboembolism. Objective. To analyze risk factors contributing to the development of venous thromboembolic complications in patients with hip pathology undergoing arthroplasty, and to substantiate its prophylactic measures. Methods. Depending on age, all patients were divided into groups: 20–40 years — 13 individuals, 41–60 years — 13 individuals, 61–80 years — 42 cases. To assess the effectiveness of thromboprophylaxis, two groups of patients diagnosed with stage III–IV idiopathic coxarthrosis aged 41 to 80 years were compared. 100 patients with various pathologies of the hip who underwent surgical treatment with endoprosthesis were involved. Results. Among the identified nosological forms of pathology, idiopathic coxarthrosis was most frequently diagnosed in patients aged 41 to 80 years. Our study demonstrated dynamic changes in the hemostatic system in patients after total hip arthroplasty when using various drugs for the prevention of thromboembolic complications, taking into account the level of antithrombin-III. In patients of the group I who received nadroparin calcium, the fibrinogen content in the blood before the operation was 4.90 (4.50–5.10) g/l, after 7 days — 4.40 (4.30–4.65), after 14 — 3.54 (2.30–3.75) g/l. In group II, thromboprophylaxis was achieved by taking dabigatran etexilate, before the operation, the fibrinogen content in the blood was 4.87 (4.45–5.15) g/l, after 7 days — 4.30 (4.20–4.50), after 14 — 3.62 (2.35–3.80) g/l. Conclusions. In patients with hip pathology, the main risk factors for venous thromboembolic complications before the endoprosthetic surgery and in the early postoperative period are age 41–80 years, obesity, arterial hypertension, as well as chronic venous insufficiency of the lower extremities. Thromboprophylaxis in total hip arthroplasty should be implemented with an individualized approach, considering not only surgical factors but also the early postoperative period.

Питання профілактики тромбоемболічних ускладнень важливе, оскільки пацієнти мають високий ризик розвитку післяопераційної венозної тромбоемболії. Мета. Проаналізувати чинники ризику розвитку венозних тромбоемболічних ускладнень у хворих із патологією кульшового суглоба після операції ендопротезування й обґрунтувати засоби їхньої профілактики. Методи. Залежно від віку всі пацієнти були поділені на групи: 20–40 років — 13 осіб, 41–60 — 13, 61–80 років — 42 випадки. Для вивчення ефективності тромбoproфілактики сформовано 2 групи хворих із діагнозом коксартроз III–IV стадії віком від 41 до 80 років. Було залучено 100 пацієнтів з різними патологіями кульшового суглоба, яким проводилось оперативне лікування з ендопротезування. Результати. За визначенням нозологічних форм патологій виявлено, що в хворих віком від 41 до 80 років найчастіше діагностовано ідіопатичний коксартроз. Нами досліджено динаміку показників системи гемостазу в осіб після ендопротезування кульшових суглобів із застосуванням різних препаратів для профілактики тромботичних ускладнень з урахуванням рівня антитромбіну-III. У хворих I групи, які одержували надропарин кальцію, до операції вміст фібриногену в крові становив 4,90 (4,50–5,10) г/л, через 7 днів — 4,40 (4,30–4,65), через 14 — 3,54 (2,30–3,75) г/л. У II групі тромбoproфілактику досягали шляхом прийому дабігатрану етексилату, до операції вміст фібриногену в крові становив 4,87 (4,45–5,15) г/л, через 7 днів — 4,30 (4,20–4,50), через 14 — 3,62 (2,35–3,80) г/л. Висновки. У хворих з патологією кульшового суглоба основними факторами ризику венозних тромбоемболічних ускладнень до операції ендопротезування та в ранньому післяопераційному періоді є вік від 41 до 80 років, ожиріння й артеріальна гіпертензія, а також хронічна венозна недостатність нижніх кінцівок. Тромбoproфілактика в разі виконання операцій тотального ендопротезування кульшового суглоба потребує індивідуального підходу до пацієнтів із урахуванням факторів ризику як у доопераційному, так і післяопераційному періодах. Ключові слова. Ендопротезування, ідіопатичний коксартроз, фактори ризику, тромбоемболічні ускладнення, антитромбін-III, тромбoproфілактика.

Keywords. Arthroplasty, idiopathic coxarthrosis, risk factors, thromboembolic complications, antithrombin III, thrombotic prevention

Introduction

Recently, joint replacement surgeries have been the most common treatment for patients with severe forms of hip joint (HJ) impairments, accounting for 75–80% of all surgical orthopedic interventions. These interventions result in the elimination of pain syndrome in approximately 85–90 % of cases, restoration of joint function, and enable patients to regain a full quality of life [1, 2].

However, with the increasing number of such surgeries, the incidence of complications also rises. Among the early and most common are venous thromboembolic and hemorrhagic complications, particularly blood loss [3]. The prevention of these issues is of great significance, as patients who undergo hip replacement surgery are at high risk for developing postoperative venous thromboembolism [4], which may recur in 25 % of cases within 7–10 years and also contribute to the development of concurrent diseases. The primary complication of deep vein thrombosis (DVT) in the lower extremities is post-thrombotic deep vein syndrome [5].

In addition, many cases of DVT of the lower extremities are asymptomatic. All this significantly worsens the quality of life of patients and requires an individual approach to the diagnosis, treatment and prevention of these thrombotic conditions, the development of appropriate measures and tactics for their implementation with the use of pharmacological agents [6].

Purpose: to analyze the risk factors for the development of venous thromboembolic complications in patients with hip joint disorders after endoprosthetic repair and to substantiate the means of their prevention.

Material and methods

The material for the study was the results of observation of 100 patients with various disorders of the hip joint, who underwent surgical treatment with endoprosthetic repair at the Department of Joint Pathology of the State Institution “Professor M. I. Sytenko Institute of Spine and Joint Pathology of the NAMS of Ukraine” for the period 2018–2024. The analysis examined the influence of age and gender on the progression of the disease, as well as on the outcomes of surgical interventions for hip joint replacement.

The study was reviewed and approved at a meeting of the Bioethics and Deontology Committee of the State Institution “Professor M. I. Sytenko Institute of Spine and Joint Pathology of the NAMS of Ukraine” (Protocol No. 253 dated 03.06.2025).

All patients provided written consent for examination and treatment. The study was performed in compliance with the requirements and provisions of the Helsinki Declaration of Human Rights (2000), including the revision of EC-GCP, the Constitution and the Fundamentals of Ukrainian Legislation on Health Care, and all ethical norms for conducting clinical trials.

Patients were categorised by age as follows: 13 cases in the 20–40 year group, 45 cases in the 41–60 year group, and 42 cases in the 61–80 year group. To study the individual thromboembolic risks of total hip replacement surgery, a validated scale was taken into account according to the Caprini scoring system [7], which provides a consistent, thorough and effective method of stratifying the risk of venous thromboembolism in patients with hip replacements and the recommendations of the American Academy of Orthopaedic Surgery (AAOS). The following criteria were used to determine the risk factors for venous thromboembolism: age, body mass index (BMI), the presence of concomitant conditions, as well as the severity and timing of the intervention.

All endoprosthetic surgeries were performed under spinal anesthesia with bupivacaine solution (5 mm/1 ml), an anterolateral approach up to 10–12 cm long was used. Cementless, cemented and hybrid versions of hip joint endoprostheses were used to fix the implants.

Blood sampling for the study was carried out from the forearm vein in the morning on an empty stomach into a special test tube with sodium citrate, for subsequent plasma collection. To assess the hemostasis system in the blood plasma of patients, the following were determined: fibrinogen content by the Claus method, soluble fibrin-monomer complexes (SFMC), fibrinolytic activity. Determination of antithrombin-III activity in blood plasma was performed by residual thrombin activity after its interaction with antithrombin-III in defibrinated plasma using ready-made reagent sets.

In our clinical study, we used protocols for the prevention of thromboembolic complications approved by the Ministry of Health of Ukraine No. 329 dated 15.06.2007 and recommendations of the American College of Thoracic Surgeons (ACTS), recommendations of the Institute of Health and Clinical Care of England and Wales (NICE).

To study the effectiveness of thromboprophylaxis, 2 groups of patients diagnosed with stage III–IV coxarthrosis aged 41 to 80 years were formed:

– I (n = 16, 8 men and 8 women) — the level of antithrombin-III ranged from 98.0 to 113.0 %. These

patients were treated with nadroparin calcium with a molecular weight of (2850 IU in 1 ml) in a prophylactic dose of 0.3 ml as a means of preventing thromboembolic complications.

– II (n = 16, 8 men and 8 women) — the level of antithrombin-III ranged from 76.0 to 92.0 %. The means of preventing thromboembolic complications was dabigatran etexilate. This agent was used prophylactically per os — 75 mg per day.

Statistical processing of data was performed using the software packages Microsoft Excel XP and Statsoft Statistica 6.0. Comparison of groups was carried out using the nonparametric Wilcoxon test with calculation of the median (Me) and percentiles (25 — 75) [8].

Results

Analysis of the composition of patients by gender showed that the ratio of men and women was 42 to 58 %, respectively. Thus, endoprosthetic repair was performed more frequently in women than in men. According to the obtained data, the development of hip joint disorders requiring endoprosthetic repair was most commonly diagnosed in patients over the age of 40; in individuals aged 41 to 80 years, it accounted for 87 %.

According to the definition of nosological forms of conditions, idiopathic coxarthrosis was most frequently diagnosed in patients aged 41 to 80 years. In elderly individuals requiring endoprosthetic repair, femoral neck fractures and traumatic instability of the implant were also observed; however, these clinical cases accounted for only 9 %, compared to 24 % in patients diagnosed with idiopathic coxarthrosis. Therefore, idiopathic coxarthrosis is the most common hip joint condition in older patients requiring total hip arthroplasty. (Table 1). In young patients, indications for hip arthroplasty are dysplastic coxarthrosis, aseptic necrosis of the femoral head, and rheumatoid arthritis.

The majority of procedures utilized total cementless arthroplasty (72 cases), while cemented techniques were performed in 18 cases and hybrid methods in 10 cases. Cemented arthroplasty was performed in patients with impaired bone mineral density (BMD), and revision arthroplasty was performed in cases of instability of the arthroplasty and in cases of femoral neck fractures.

Hip replacement surgery is known to be a surgical procedure with a high risk of developing thrombotic conditions. Several constant factors contribute to its increase, including advanced age (over 60 years) and the presence of concomitant conditions such as severe cardiopulmonary diseases, ischemic heart disease, and pulmonary hypertension. [9]. Additionally, risk factors include various comorbid conditions, in particular, high BMI and neuromuscular diseases [10, 11].

Ek. Carlino et al. found an increased rate of complications in patients with higher BMI, although the exact threshold value at which the risk of complications becomes unacceptable remains uncertain. However, there are contradictions in the literature regarding the influence of high BMI on the development of venous thromboembolism [12].

Among the patients included in our study, the BMI distribution was as follows: 37 % had a normal weight, 27 % were overweight, and the remaining 36 % had varying degrees of obesity. Overall, overweight women were more prevalent, comprising 37 out of 63 patients, with the remaining 26 patients being men (Table 2).

The most common risk factors included the development of arterial hypertension: Stage I–II in 20 % of patients, and Stage III–IV in 13 %, respectively. However, it should be noted that the arterial hypertension detected in patients was controlled, that is, patients received antihypertensive therapy.

Considerable attention should also be given to assessing the history of chronic gastric ulcers in patients, as this necessitates an individualized approach

Distribution of patients by nosological forms of hip joint conditions

Table 1

Patient age, years	20–40		41–60		60–80		Total	
Nosology	abs.	%	abs.	%	abs.	%	abs.	%
Idiopathic coxarthrosis	—	—	36	36.0	24	24.0	60	60.0
Dysplastic coxarthrosis	5	5.0	11	11.0	4	4.0	20	20.0
Aseptic necrosis of the femoral head	3	3.0	2	2.0	—	—	5	5.0
Rheumatoid arthritis	1	1.0	3	3.0	2	2.0	6	6.0
Fracture of the femoral neck	—	—	—	—	7	7.0	7	7.0
Traumatic instability of the endoprosthesis	—	—	—	—	2	2.0	2	2.0
Total	9	9.0	52	52.0	39	39.0	100	100.0

to both the prescription of anticoagulants and the surgical procedure. It is clear that endoprosthetic surgery for such individuals should only be performed when the gastric ulcer is in remission, as the condition may worsen during the postoperative period (Table 3). The percentage of concomitant conditions in patients requiring endoprosthetic surgery was 61.5 % for those aged 20–40 years, 86.7 % for those aged 41–60 years, and 95.2 % for those aged 61–80 years.

We investigated the time course of hemostasis system indicators in patients after hip replacement surgery using various agents for the prevention of thrombotic complications, taking into account the level

of antithrombin-III. In patients of Group I who received nadroparin calcium, the fibrinogen content in the blood was 4.90 (4.50–5.10) g/l before surgery, 4.40 (4.30–4.65) after 7 days, and 3.54 (2.30–3.75) g/l after 14 days. In Group II, thromboprophylaxis was achieved by taking dabigatran etexilate; before surgery, the fibrinogen content in the blood was 4.87 (4.45–5.15) g/l, 4.30 (4.20–4.50) after 7 days, and 3.62 (2.35–3.80) g/l after 14 days.

Therefore, one of the important criteria for choosing agents for thromboprophylaxis in patients with joint disorders requiring endoprosthetic repair can be considered antithrombin-III — a heparin cofactor that inactivates thrombin, which prevents the development of thrombosis.

Therefore, antithrombin-III, a heparin cofactor that inactivates thrombin and helps prevent the development of thrombosis, can be considered one of the key criteria for selecting thromboprophylaxis agents in patients with joint disorders requiring endoprosthetic repair. In the case of a decrease in antithrombin-III in the blood due to various factors (in the postoperative period), heparin loses its anticoagulant effect. Low-molecular-weight heparin drugs — Clexane, Fraxiparine — also act in the same way, since their mechanism is binding to antithrombin-III. If its low concentration is detected in the blood of patients before surgery, it becomes inappropriate to prescribe low-molecular-weight heparin drugs that act through antithrombin-III. An alternative option is dabigatran, an anticoagulant agent that operates through a different mechanism by directly inhibiting

Table 2

Distribution of patient groups by BMI before surgery

BMI, kg/m ²	Number of patients (n)	Percentage (%)
Normal body mass		
18.50–24.99	37	37.0
Excess body weight (pre-obesity)		
25.00–29.99	27	27.0
First-degree obesity		
30.00–34.99	11	11.0
Second-degree obesity		
35.00–39.99	19	19.0
Third-degree obesity		
40.00–44.99	4	4.0
Fourth-degree obesity		
> 45.00	2	2.0
Total	100	100.0

Table 3

Comorbidity detected in patients before hip replacement surgery

Патологія	Вік (роки) і кількість хворих		
	20–40 (n = 13)	41–60 (n = 45)	61–80 (n = 42)
Arterial hypertension of stages I–II	—	10	10
Arterial hypertension of stages III–IV	—	5	8
Rheumatoid arthritis	1	—	—
Pulmonary disorders	—	1	2
Kidney disorders	—	3	2
A history of gastric ulcer	1	2	3
Hepatitis C	1	1	—
A history of hormone therapy	1	4	5
A history of antibiotic therapy	1	5	—
Granulating vasculitis	1	—	—
Chronic venous insufficiency	—	6	7
A history of lower limb erysipelas	—	2	—
Type II diabetes mellitus	2	1	3
Number of patients with concomitant conditions	8	39	40

thrombin and preventing thrombus formation. Thus, the preventive effect of thrombus formation is achieved without the participation of its own anticoagulant factor, antithrombin-III [13]. In our opinion, the choice of this approach is fully pathogenetically justified, as there is no consensus among specialists on the optimal method of antithrombotic prophylaxis to balance the risks of thrombosis and minimize bleeding in patients undergoing endoprosthetic surgery.

Discussion

Venous thromboembolism cannot be considered an absolute, but is a relative contraindication to performing hip arthroplasty, as stated by H. Choe et al. However, DVT, especially in the iliac-femoral vein, is an absolute modified contraindication for elective endoprosthetic repair. Surgical intervention can displace existing thrombi, which will potentially cause life-threatening complications [14].

Therefore, it is important to identify patients with a history of venous thromboembolic conditions, which is a dangerous risk factor for complications during hip replacement and requires an individual approach to prevention [15]. In particular, in our study, chronic venous insufficiency of the lower extremities was diagnosed in 15 % of cases.

Also, the development of obesity ($BMI > 30 \text{ kg/m}^2$) is a significant risk factor for venous thromboembolism in patients who require hip replacement, because they lead a sedentary lifestyle. Therefore, performing hip replacement is more difficult due to an increase in the average time of the operation (80–120 min) and an increase in the likelihood of hemorrhagic and thrombotic complications. In addition, motor activity decreases in the postoperative period. All these factors cause disruption of the hemostasis system and the development of venous thrombosis and even create risks of pulmonary embolism; therefore they require mandatory thromboprophylaxis [16, 17].

To assess the degree of risk for venous thromboembolism and develop a prevention plan, four main periods were distinguished: the first, preoperative (2–5 days before the intervention); the second, intraoperative; the third, early postoperative (10–14 days after the intervention); and the fourth, late postoperative (2–3 months after the intervention).

In the preoperative period, the main task was to determine the etiological causes of vascular thrombosis in patients. This was achieved through a thorough study of disease histories, in particular, history taking and clinical examination with special attention to the examination of the venous system of the lower ex-

trémities and pelvis visually and according to the results of ultrasound examination. The functional state of the cardiovascular system, liver, kidneys, as well as the presence of peptic ulcer of the gastrointestinal tract were analyzed.

Attention was given to the physical condition of patients, including measurements of height, weight, and blood pressure. BMI was calculated, motor activity assessed, and necessary laboratory tests, including biochemical blood tests and coagulation assessments, were performed.

Also of great importance in the preoperative period is the identification of conditions and impairments that may cause violations of the hemostasis system in the intraoperative period. Therefore, it is important to individually plan not only the operation itself, but also to determine risk factors for the justified appointment of preventive measures for the development of venous thromboembolic complications.

In the intraoperative period, minimal trauma is the most important and fundamental aspect. An important point during the operation is the surgeon's rational access to the hip joint, as well as an individual approach to choosing the type of anesthesia. It is mandatory to use a blood content aspiration system during the surgeon's treatment of bone tissue in the acetabular fossa and femoral canal of the femur, especially in places where a blood clot forms. The second important point during the operation is the correct use of the vascular coagulation technique to stop bleeding, because excessive cauterization of the vessels causes a coagulation flow that can cause the development of thrombosis. In addition, it is caused by trauma (compression) of blood vessels with instruments during the operation. Therefore, training assistants during the operation to correctly perform actions using surgical instruments, as well as carefully perform the procedure for dislocation of the femoral head or reduction of the endoprosthesis head, is a necessary prerequisite. These procedures can injure both periarticular nerve and vascular formations, which is also a thrombohazardous moment.

We also evaluated such indicators as the total time of the operation (on average it was 90 ± 20 min) and blood loss, which was on average (300 ± 100) ml, and in cases of cement endoprosthesis, the thermal effect of bone cement on the state of blood pressure and somatic status of the patient. During the intraoperative period, it is rational to administer anesthesia not only for the surgical procedure itself but also to ensure appropriate dilution, use dextrans to improve blood rheology, prevent aggregation of blood cells, and reduce the risk of thrombosis.

After the operation, it is necessary to use compression elastic bandaging of the lower extremities or use compression knitted stockings as a preventive measure for the development of venous thromboembolism for 10–14 days after the operation, with the exception of patients with chronic venous insufficiency.

The early postoperative period requires special attention, since postoperative complications, such as venous thromboembolism and other diseases, are the main risk factors for mortality in this period. Dynamic control of postoperative wound healing, appropriate infusion therapy, which prevents hemostasis and improves the rheological properties of blood, is of fundamental importance. Patients with various hip joint conditions have been found to have changes in hemostasis system markers following endoprosthetic surgery.

Patients who underwent thromboprophylaxis with low molecular weight heparins have been shown to have a certain percentage of lower limb vein thrombosis in the early postoperative period, which justifies the search for rational schemes. They should be formed taking into account the concentration of antithrombin-III, since its decrease in the blood can serve as a criterion for choosing a thromboprophylactic agent to prevent the development of venous thrombosis [18].

Thus, after hip replacement surgery, activation of blood coagulation is observed in the form of impaired fibrinolysis, and the use of laboratory markers, in particular, the content of fibrinogen and antithrombin-III, allows detecting an imbalance in the fibrinolytic link of hemostasis and forming the principles of thromboprophylaxis.

It is worth noting that impaired hemostasis leads to thrombosis of deep veins of the extremities, therefore, control of biochemical blood parameters should occur before and after surgery.

Conclusions

The main factors contributing to the risk of venous thromboembolic complications in patients with hip joint disorders, both before hip arthroplasty and during the early postoperative period, include age (41 to 80 years), obesity, arterial hypertension, and chronic venous insufficiency of the lower extremities.

Laboratory markers that assess the dynamics of hemostasis changes and predict thromboembolic complications in postoperative patients include blood fibrinogen levels, fibrinolytic activity, and antithrombin-III levels. Its indicator can reasonably be considered one of the most important criteria when

choosing drugs for the prevention of thromboembolic complications in patients after arthroplasty.

Thromboprophylaxis in the case of total hip arthroplasty requires an individual approach to patients, taking into account risk factors both in the preoperative and postoperative periods.

Conflict of interest. The authors declare no conflict of interest.

Prospects for further research. Assessing laboratory markers to minimize thromboembolic risks and complications during endoprosthetic repair.

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Contribution of the authors. Vysotsky O. V. — drafting the article and collecting data; Bondarenko S. Ye. — research management, analysis of findings.

References

1. Frydendal, T., Christensen, R., Mechlenburg, I., Mikkelsen, L. R., Varnum, C., Graversen, A. E., Kjærsgaard-Andersen, P., Revald, P. H., Hofbauer, C., Bieder, M. J., Qassim, H., Munir, M. S., Jakobsen, S. S., Nielsen, S. M., Ingwersen, K. G., & Overgaard, S. (2024). Total hip replacement or resistance training for severe hip osteoarthritis. *New England journal of medicine*, 391(17), 1610–1620. <https://doi.org/10.1056/nejmoa2400141>
2. Korftsen, C. B., Mikkelsen, L. R., Mikkelsen, M., Rohde, J. F., Holm, P. M., Tarp, S., Carlsen, H. F., Birkefoss, K., Jakobsen, T., Poulsen, E., Leonhardt, J. S., Overgaard, S., & Mechlenburg, I. (2023). Hip precautions after posterior-approach total hip arthroplasty among patients with primary hip osteoarthritis do not influence early recovery: A systematic review and meta-analysis of randomized and non-randomized studies with 8,835 patients. *Acta orthopaedica*, 94, 141–151. <https://doi.org/10.2340/17453674.2023.11958>
3. Ramezani, A., Ghaseminejad Raeni, A., Sharafi, A., Sheikhatvatan, M., Mortazavi, S. M., & Shafiei, S. H. (2022). Simultaneous versus staged bilateral total hip arthroplasty: A systematic review and meta-analysis. *Journal of orthopaedic surgery and research*, 17(1). <https://doi.org/10.1186/s13018-022-03281-4>
4. Keller, K., Hobohm, L., Barco, S., Schmidtman, I., Münzel, T., Engelhardt, M., Goldhofer, M., Konstantinides, S. V., & Drees, P. (2020). Venous thromboembolism in patients hospitalized for hip joint replacement surgery. *Thrombosis research*, 190, 1–7. <https://doi.org/10.1016/j.thromres.2020.03.019>
5. Keller, K., Hobohm, L., & Engelhardt, M. (2018). Risk of venous thromboembolism after endoprosthetic surgeries: Lower versus upper extremity endoprosthetic surgeries. *Heart and Vessels*, 34(5), 815–823. <https://doi.org/10.1007/s00380-018-1305-3>
6. Simon, S. J., Patell, R., Zwicker, J. I., Kazi, D. S., & Hollenbeck, B. L. (2023). Venous thromboembolism in total hip and total knee arthroplasty. *JAMA network open*, 6(12), e2345883. <https://doi.org/10.1001/jamanetworkopen.2023.45883>
7. Cronin, M. A., Dengler, N., Kraus, E. S., Segal, A., Daly, M., Mota, F., & Caprini, J. A. (2021). Rules for assessing the risk of venous thromboembolism using the Caprini scale. Health of Ukraine. (in Ukrainian)
8. Ognev, V. A. (2023). Social medicine, public health. teaching aids: in 4 volumes. Kharkiv, Biological statistics. (in Ukrainian)
9. Bondarenko, S., & Parvizi, J. (2025). Recommendations of the World Congress of Experts on Joint Endoprosthe-

- sis: a manual. NAMS of Ukraine, State Institution "Prof. M. I. Sytenko Institute of Spine and Joint Pathology of NAMS of Ukraine". Kharkiv: Tochka.
10. Filipenko, V. A., Tankut, V. O., Mezentssev, V. O., & Ovchinnikov, O. M. (2017) Causes of dislocation of the endoprosthesis head after primary hip replacement. *Trauma*. 18 (1), 27–33. (in Ukrainian)
 11. Filipenko, V. A., Tankut, V. O., Kolesnichenko, V. A., Mezentssev, V. O., & Ovchinnikov, O. M. (2018). The main criteria for predicting dislocation of the endoprosthesis head in patients with femoral neck fractures after unipolar hip arthroplasty. *Trauma*, 19(1), 113–120. <https://doi.org/10.22141/1608-1706.1.19.2018.126670>. (in Ukrainian)
 12. Carlino, E. K., Cichos, K. H., Al Maskari, S., Burgo, F. J., De Steiger, R., Ekhtiari, S., Spooner, A., Yildiz, F., & Ghanem, E. S. (2025). Is there a threshold limit for body mass index for patients undergoing primary total knee or total hip arthroplasty? *The journal of arthroplasty*, 40(2), S18–S20. <https://doi.org/10.1016/j.arth.2024.10.040>
 13. Lieberman, J. R., & Bell, J. A. (2021). Venous Thromboembolic prophylaxis after total hip and knee arthroplasty. *Journal of bone and joint surgery*, 103(16), 1556–1564. <https://doi.org/10.2106/jbjs.20.02250>
 14. Choe, H., Indelli, P. F., Ricciardi, B., Kim, T., Homma, Y., Kigera, J., Veloso Duran, M., & Khan, T. (2025). What are the absolute contraindications for elective total knee or hip arthroplasty? *The journal of arthroplasty*, 40(2), S45–S47. <https://doi.org/10.1016/j.arth.2024.10.041>
 15. Summers, S., Yakkanti, R., Ocksrider, J., Haziza, S., Mannino, A., Roche, M., & Hernandez, V. H. (2021). Effects of venous insufficiency in patients undergoing primary total knee arthroplasty: An analysis of 1.2 million patients. *The journal of knee surgery*, 36(03), 322–328. <https://doi.org/10.1055/s-0041-1733901>
 16. Karasavvidis, T., Bouris, V., Xiang, W., Tzavellas, G., Charisis, N., Palaodimos, L., Kigka, V., Bourantas, C. V., & Gkias, I. (2022). Prophylaxis for venous Thromboembolic events in elective total hip and TotalKnee arthroplasty. *Current pharmaceutical design*, 28(10), 771–777. <https://doi.org/10.2174/1381612828666220418090928>
 17. Rudy, M. D., & Grant, P. J. (2024). The patient with hip fracture. *Medical clinics of North America*, 108(6), 1155–1169. <https://doi.org/10.1016/j.mena.2024.04.004>
 18. Borjas-Howard, J., Nasserinejad, K., Leebeek, F., Meijer, K., & Croles, F. (2018). Risk of venous thrombosis in antithrombin deficiency: A systematic review and Bayesian meta-analysis. *Seminars in thrombosis and hemostasis*, 44(04), 315–326. <https://doi.org/10.1055/s-0038-1625983>

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ANALYSIS OF RISK FACTORS AND ASSESSMENT OF PREVENTION OF VENOUS THROMBOEMBOLIC COMPLICATIONS IN PATIENTS WITH HIP JOINT REPLACEMENT

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