

ULTRASOUND THROMBOELASTOGRAPHY FOR THE CHOICE OF TREATMENT OF PATIENTS WITH POSTOPERATIVE VENOUS THROMBOSIS

S.Ya. Kostiv, *D.V. Khvalyboha, I.K. Venher, O.I. Zarudna, O.I. Kostiv
I. HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE

Background. *The frequency of venous thromboembolic complications in surgery practice is rather high. In many cases, it is the cause of a fatal pulmonary embolism. One of the actual tasks of ultrasonic diagnostics of acute venous thrombosis is the visual assessment of the substrate of the disease because it determines angiosurgical tactics and surgical prophylaxis of pulmonary embolism.*

The objective was to prevent the development of pulmonary embolism in patients with postoperative venous thrombosis of the inferior vena cava system.

Methods. *Vena cava system investigation and the determination of the sonoelastographic properties of the venous thrombus were carried out with the Siemens Acuson S2000 ultrasound system. The localization and prevalence of the thrombotic process were established. At the end of the topical diagnosis of a venous thrombus, the sonoelastographic properties of the thrombus were studied by determining the speed of propagation of the acoustic wave.*

Results. *The work is based on the results of examination and surgical treatment of 729 patients, of which 205 (28.12%) had operative interventions on the musculoskeletal system, 378 (51.85%) – on the abdominal organs, 146 (20.01%) – reconstructive surgery on the aorta and the main arteries of the lower extremities.*

Conclusions. *Embolodengerous thrombi are those venous thrombi of the inferior vena cava system which at ultrasonoelastography of the proximal segments of the venous thrombus are characterized by the acoustic wave propagation velocity within 2.5–2.8 m/s. The detection of embolic venous thrombosis is an indication for surgical methods prevention of pulmonary embolism.*

KEY WORDS: **pulmonary embolism; postoperative deep vein thrombosis; inferior vena cava.**

Introduction.

The frequency of venous thromboembolic complications ranges from 10 to 40% in patients with a surgical profile [1]. Postoperative venous thrombosis in 5-10% is the cause of fatal pulmonary embolism (PE) [2, 3]. One of the actual tasks of ultrasonic diagnostics of acute venous thrombosis (AVT) is a visual assessment of the substrate of the disease since the results obtained determine angiosurgical tactics of treatment and method of surgical prophylaxis of PE if it is necessary [4].

The risk of developing lower extremity deep vein thrombosis and pulmonary artery thromboembolism is higher in patients with surgical diseases. However, more than half of intra-hos-

pital fatal episodes of pulmonary artery thromboembolism are recorded in patients with a nonsurgical profile. According to the Framingham study, pulmonary embolism accounts for 15.6% of all in-hospital mortality, with surgical patients accounting for 18% and 82% of patients with therapeutic pathology. Long-term mobility limitation of neurologic patients, inoperable cancer and hematologic diseases, complex pathology in elderly patients, and other risk factors are no less threatening predictors of venous thromboembolism than surgery.

Along with this, ultrasound examination in patients with suspected AVT can establish a correct diagnosis only in case of typical manifestations of the disease, while the frequency of diagnostic errors reaches 50% [5]. In several cases, fatal PE after the ultrasound in patients with postoperative AVT in the basin of inferior

*Corresponding Author: Dymytrii V. Khvalyboha, I. Horbachevsky Ternopil National Medical University, Maidan Voli, 1, 46000, Ternopil, Ukraine. E-mail: varjh2@gmail.com

vena cava (IVC) [6], which encourages the search for more effective methods of diagnosis of embologenic venous thrombosis.

The **objective** of the study is to prevent the development of PE in patients with postoperative venous thrombosis of the inferior vena cava system.

Methods

The investigation of the IVC system and the determination of the sonoelastographic properties of the venous thrombus were carried out with the Siemens Acuson S2000 ultrasound system (Germany).

In the ultrasound examination of IVC system, localization and prevalence of the thrombotic process were established. At the end of the topical diagnosis of a venous thrombus, the sonoelastographic properties of the thrombus were studied by determining the speed of propagation of the acoustic wave.

At a speed of acoustic wave propagation in the range 2.5-2.6 m/s there is a high risk of embolism, while at a speed of propagation of an acoustic wave within 2.7-2.9 m/s there is a moderate risk of embolism, and at the acoustic wave propagation of 3.0 m/s and higher, the patient does not experience any risk of embolism.

All participants signed written informed consent. The trial was approved by the Ethical Committee of I. Horbachevsky Ternopil National Medical University.

Results

The work is based on the results of examination and surgical treatment of 729 patients, of which 205 (28.12%) had operative interventions on the musculoskeletal system, 378 (51.85%) – on the abdominal organs, 146 (20.01%) – reconstructive surgery on the aorta and the main arteries of the lower extremities.

According to the J. Caprini (2012) scale, 316 (43.35%) patients had a very high risk of developing thromboembolic complications, and 413 (56.64%) – a high risk. Thromboprophylaxis to patients was carried out in accordance with the provisions of the ACCP (2016).

Postoperative thrombosis in the IVC system was diagnosed in 118 (16.19%) cases. The thrombotic process in the deep vein system was diagnosed in 106 (88.89%), and varicothrombophlebitis – in 12 (10,17%) observations.

In 4 (3.77%) patients the thrombotic process in the deep veins was diagnosed at the end of the second day of the postoperative period. In 22 (20.76%) patients thrombotic process was

recorded on the 3rd day after surgery, in 36 (33.96%) patients – on the 4th day, in 29 (27.36%) observations – on the 5th day, 15 (14,15%) patients – on the 6-7th day of the postoperative period.

Postoperative varicothrombophlebitis in 4 cases was diagnosed on day 4 after surgery, in 7 cases – on day 5 and in 1 case – on day 6 of the postoperative period.

At the ultrasonoelastography of the flotation segment of the ileum-femoral venous thrombus, the acoustic wave propagation velocity was 2.5-2.6 m/s (1 observation), the flotation segment of the common femoral vein was 2.5-2.6 m/s (4 observations). The proximal segment of 2.6 to 2.9 cm in length of the femoropopliteal venous thrombus was characterized by the acoustic wave propagation velocity at the level of 2.7-2.8 m/s (3 out of 45 observations).

Thrombosis of soleus and fibular sinuses with continuation into the popliteal vein was characterized by a velocity of acoustic wave propagation of 2.5–2.6 m/s (2 observations). The proximal segment with a length of 1.2-1.5 cm of the tibia-popliteal thrombus was characterized by a velocity of acoustic wave propagation within the limits of 2.7-2.8 m/s (2 out of 49 observations).

Embolic forms of postoperative deep vein thrombosis in IVC system were diagnosed on the 3rd (2 observations), 4th (7 cases) and 5th (3 observations) postoperative days.

Embolic dangerous postoperative thrombi of the deep veins of IVC system in 7 cases were found in patients after surgical interventions on the musculoskeletal system, in 4 cases – after surgery on the abdominal organs and in 1 case – after reconstructive surgery on the aorta and the main arteries of the lower limbs.

In 7 cases at ultrasonoelastography of the postoperative venous thrombus of deep vein, the propagation velocity of the acoustic wave was 2.5-2.6 m/s, which indicated a high risk of embolism of the thrombus.

In 5 cases at ultrasonogastography of a venous thrombus, the acoustic wave propagation velocity was 2.7-2.8 m/s, a moderate risk of embolism of the thrombus. In all 12 (11.32%) cases of embolic forms of deep vein thrombosis, with the aim of preventing PE, urgent surgical procedures were performed.

In one of 12 cases of postoperative varicothrombophlebitis on the 4th day after surgery, the proximal segment of the thrombotic process was localized at the level of the sapheno-femoral anastomosis. The propagation velocity

of the acoustic wave of this segment of phlebothrombosis ranged from 2.7 to 2.8 m/s. Operative intervention in the form of a crossectomy and short stripping of a large saphenous vein was performed.

105 patients with postoperative venous thrombosis were prescribed anticoagulant therapy with low molecular weight heparins.

Discussion

316 (43.35%) patients underwent surgical treatment, according to the J. Caprini scale these patients had a very high risk of developing thromboembolic complications, 413 (56.65%) patients had a high risk of developing thromboembolic complications. Thromboprophylaxis at surgical interventions was carried out in accordance with the provisions of the ACCP [7]. In 118 (16.19%) cases, the development of postoperative venous thrombosis was established. Studies by several authors [8,9] state that, despite all the efforts of thromboprophylaxis measures, postoperative venous thrombosis in 5–10% is a source of PE that is fatal in 0,3–3,7% [10].

One of the actual tasks of ultrasound diagnosis at acute venous thrombosis is a visual assessment of the substrate of the disease. During the ultrasound examination, localization, the prevalence of the thrombotic process, and the shape of the apex of thrombotic masses were established [11]. The greatest danger in the development of PE is caused by two types of embolic venous thrombi: segmental floating and widespread occlusive thrombi with a floating tip. When they are detected, indications for the operative treatment of AVT become obligatory [12].

Ultrasound examination in patients with suspected AVT allows the diagnostics primarily at typical manifestations of the disease [10, 11]. Diagnostic errors may occur in the presence of fresh thrombotic masses that are not fixed to the venous wall, when the thrombotic process spreads from the veins of the tibia to the popliteal vein, with the dissemination of the thrombotic process from the soleus and peroneal sinuses into the popliteal vein.

These examples of the thrombotic process in the venous system are dangerous in terms of the development of venous thromboembolic complications [8; 12]. To establish the embolism of thrombus, a technique of determining the density of thrombotic masses is used [7]. The method does not allow to reliably estimate the results of the study since in addition to venous

thrombosis the surrounding tissues are placed in the research interest zone.

A more objective and reliable method of diagnosing an embolic thrombus is the technique for determining the speed of propagation of an acoustic wave in a thrombotic mass by the sonoelastography system Siemens Acuson S2000 (Germany). At a speed of acoustic wave propagation in the range 2.5-2.6 m/s there is a high risk of embolism, at a speed within 2.7-2.9 m/s – moderate risk of embolism, at a speed of 3.0 m/s and higher there is no threat of embolism.

In 7 cases, the acoustic wave propagation velocity was established at a level of 2.5-2.6 m/s, which indicated a high risk of embolism. In 5 cases, it was determined that the acoustic wave propagation velocity was 2.7-2.8 m/s – moderate risk of embolism of the thrombus.

In all 12 (11.32%) cases of embolic forms of postoperative venous thrombosis, with the aim of preventing PE, urgent surgical procedures were performed in order to prevent PE.

A sonoelastographic method of determining the embolism of postoperative venous thrombosis was used, and when it was established, urgent surgical procedures were performed. It was possible to prevent the development of PE after surgical treatment in 729 patients with a very high (43.35 %) and high (56.64 %) risk of developing tromboembolic complications.

Conclusions

Pulmonary embolism is one of the most common causes of death from cardiovascular disease. Clinical assessment using ultrasonoelastography helps to identify patients with clinical probability of venous thromboembolism. The results of our research demonstrated that embolodangerous thrombi of the proximal segments of the venous thrombus are characterized by the acoustic wave propagation velocity within 2.5-2.8 m/s. The detection of embolic venous thrombosis is an indication for conducting surgical methods for the prevention of pulmonary embolism.

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Conflict of Interests

The authors declare no conflict of interest.

Author Contributions

Kostiv S.Ya. – data curation, methodology, writing – review and editing; *Khvalyboha D.V.* – formal analysis, investigation, resources, writing – original draft; *Venher I.K.* – conceptualization, supervision; *Zarudna O. I.* – validation; *Kostiv O.I.* – software.

УЛЬТРАЗВУКОВА ТРОМБОЕЛАСТОГРАФІЯ У ВИБОРІ ЛІКУВАННЯ ХВОРИХ З ПІСЛЯОПЕРАЦІЙНИМ ВЕНОЗНИМ ТРОМБОЗОМ

С. Я. Костів, Д. В. Хвалибога, І. К. Венгер, О. І. Зарудна, О. І. Костів
ТЕРНОПІЛЬСЬКИЙ НАЦІОНАЛЬНИЙ МЕДИЧНИЙ УНІВЕРСИТЕТ ІМЕНІ І. Я. ГОРБАЧЕВСЬКОГО МОЗ УКРАЇНИ

Вступ. Частота венозних тромбоемболічних ускладнень в хірургічній практиці досить висока. У багатьох випадках це причина летальної тромбоемболії легеневої артерії. Одним з актуальних завдань ультразвукової діагностики гострого венозного тромбозу є візуальна оцінка субстрату захворювання, оскільки він визначає ангіохірургічну тактику та хірургічну профілактику тромбоемболії легень.

Метою дослідження було запобігти розвитку тромбоемболії легеневої артерії у пацієнтів із післяопераційним венозним тромбозом системи нижньої порожнистої вени.

Методи дослідження. Дослідження системи порожнистої вени та визначення соноеластографічних властивостей венозного тромбу проводили за допомогою ультразвукової системи Siemens Acuson S2000. Встановлено локалізацію та поширеність тромботичного процесу. Наприкінці актуального діагнозу венозного тромбу вивчали соноеластографічні властивості тромбу шляхом визначення швидкості поширення акустичної хвилі.

Результати й обговорення. Робота заснована на результатах обстеження та хірургічного лікування 729 пацієнтів, з них 205 (28,12%) оперативних втручань на опорно-руховому апараті, 378 (51,85%) – на органах черевної порожнини, 146 (20,01%) – реконструктивна хірургія на аорті та основних артеріях нижніх кінцівок.

Висновки. Емболонебезпечні тромби – це венозні тромби системи нижньої порожнистої вени, які при ультрасоноеластографії проксимальних сегментів венозного тромбу характеризуються швидкістю поширення акустичної хвилі в межах 2,5–2,8 м / с. Виявлення емболічного венозного тромбозу є показанням до хірургічних методів профілактики тромбоемболії легеневої артерії.

КЛЮЧОВІ СЛОВА: тромбоемболія легеневої артерії; післяопераційний тромбоз глибоких вен; нижня порожниста вена.

Відомості про авторів

Костів С. Я. – доктор медичних наук, професор, професор кафедри хірургії № 2, Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України, м. Тернопіль

Хвалибога Д. В. – аспірант кафедри хірургії № 2, Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України, м. Тернопіль

Венгер І. К. – доктор медичних наук, професор, завідувач кафедри хірургії № 2, Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України, м. Тернопіль

Зарудна О. І. – кандидат медичних наук, доцент, доцент кафедри клінічної імунології, алергології та загального догляду за хворими, Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України, м. Тернопіль

Костів О. І. – кандидат медичних наук, доцент, доцент кафедри анестезіології та інтенсивної терапії, Тернопільський національний медичний університет імені І. Я. Горбачевського МОЗ України, м. Тернопіль

Information about the authors

Kostiv S. Ya. – MD, Ph.D., DSc, Professor of the Department of Surgery № 2, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine.

ORCID 0000-0002-7963-5425, e-mail: kostivsj@tdmu.edu.ua

Khvalyboha D. V. – Postgraduate Student of the Department of Surgery № 2, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine.

ORCID 0000-0003-0168-0848, e-mail: varjh2@gmail.com

Venger I. K. – DSc, MD, Ph.D., Professor, Head of the Department of Surgery № 2, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine.

ORCID 0000-0003-0170-1995, e-mail: vengerik@tdmu.edu.ua

Zarudna O. I. – MD, Ph.D., Associate Professor of the Department of Clinical Immunology, Allergology and General Patient Care, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine.

ORCID 0000-0002-9374-3991, e-mail: zarudna@tdmu.edu.ua

Kostiv O. I. – MD, Ph.D., Associate Professor of the Department of Anesthesiology and Intensive Care, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine.

ORCID 0000-0001-5421-9532, e-mail: kostivo@tdmu.edu.ua

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