

COMPLICATIONS AFTER JOINT REPLACEMENT SURGERIES (SHORT TERM, MIDTERM AND LONG TERM)

Dhillon H.S.^{1,2}, Serova N.S.¹, Lychagin A.V.¹

Purpose. Complications after hip/knee/other joint arthroplasty develop in approximately 1–1.5% of young people and in 2.5–3% of elderly patients. Despite the meager chance of developing negative consequences, they can affect anyone, especially those who did not follow the rigorous rehabilitation program. Complications after endoprosthetics of hip/knee/other joints results from incorrect postoperative care and physical activity after discharge from the hospital. The second reason is technical approach of the surgeon. And third is an inadequate preoperative examination. The aim of the article is to have a detailed description of short term, midterm and long-term complications after joint replacement surgeries and of the methods (clinical and radiological) to avoid those complications with all the required parameters.

Keywords: total knee prosthesis, total hip prosthesis, dislocation of prosthesis, infection, pulmonary thromboembolism, physiotherapy.

Corresponding author: Dhillon H.S., e-mail: harmeetsingh333@mail.ru

For citation: Dhillon H.S., Serova N.S., Lychagin A.V. Complications after joint replacement surgeries (short term, midterm and long term). REJR 2018; 8 (3):100-106. DOI:10.21569/2222-7415-2018-8-3-100-106.

Received: 09.06.18

Accepted: 28.06.18

ОСЛОЖНЕНИЯ ПОСЛЕ ЭНОПРОТЕЗИРОВАНИЯ СУСТАВОВ (РАННИЙ, СРЕДНИЙ И ПОЗДНИЙ ПОСЛЕОПЕРАЦИОННЫЕ ПЕРИОДЫ)

Диллон Х.С.^{1,2}, Серова Н.С.¹, Лычагин А.В.¹

Цель исследования. Осложнения после эндопротезирования тазобедренных, коленных или других суставов встречаются примерно в 1-1,5% случаев у молодых людей и у 2,5-3% пожилых пациентов. Риск развития осложнений после таких операций может встречаться у всех пациентов, особенно у тех, кто не следует строгой программе реабилитации. Осложнения после эндопротезирования тазобедренного или коленного суставов могут возникнуть из-за некорректного ведения пациента в послеоперационном периоде или неадекватной физической активности после выписки из стационара. Вторая причина возникновения осложнений – различные технические подходы лечащего хирурга. И третья причина – недостаточное предоперационное обследование.

Цель данной статьи – представить подробное описание осложнений после эндопротезирования суставов в ранний, средний и поздний послеоперационные периоды, а также описание диагностических методов (клинических и рентгенологических) для снижения риска возникновения осложнений.

Ключевые слова: тотальное протезирование коленного сустава, тотальное протезирование тазобедренного сустава, дислокация протеза, инфекционные изменения, тромбоэмболия легочной артерии, физиотерапия.

Контактный автор: Диллон Х.С., e-mail: harmeetsingh333@mail.ru

Для цитирования: Диллон Х.С., Серова Н.С., Лычагин А.В. Осложнения после эндопротезирования суставов (ранний, средний и поздний послеоперационные периоды).

1 - Sechenov University. Moscow, Russia.

2 - Dr. Sunny Medical Centre. Al Shahba, Sharjah, UAE.

1 – Сеченовский Университет. Москва, Россия.

2 - Медицинский Центр доктора Санни. Аль Шахба, Шарджа, ОАЭ.

Complications after hip/knee/other joint arthroplasty develop in approximately 1 – 1.5 % of young people and in 2.5 – 3 % of elderly patients [1, 4, 18]. Despite the meager chance of developing negative consequences, they can affect anyone, especially those who did not follow the rigorous rehabilitation program. Complications after endoprosthetics of hip/knee/other joints results from incorrect postoperative care [14, 16, 36] and physical activity after discharge from the hospital [2, 10]. The second reason is technical approach of the surgeon [3, 18]. And third is an inadequate preoperative examination [8, 22, 29], as a result of which subclinical infections (urinary; bronchopulmonary) flare up after the joint replacement surgery. The success of the treatment is influenced by the qualification of the medical staff, where the patient received high-tech medical, surgical and rehabilitation treatment [6, 27].

Causes / Reasons for Joint replacement Surgeries:

The most common reasons for a joint replacement surgery according to the study as shown in Fig. 1. Osteoarthritis being the prime reason in elderly [13, 19] and Trauma in young patients [11, 29].

Statistics of complications in percentage:

The operation to install the prosthesis is the method that mobilizes the patient, changes the lifestyle of patient, relieves debilitating pain and limited ability to work, reverts to healthy physical activity [15, 39]. Unpleasant pathological situations associated with implantation occur infrequently, which the patient should be informed about before the operation. According to the study, the complications are divided into early/short term comprises from 1-8 weeks post operation, midterm comprising from 2-12 months and late term comprising from 1 to 5 years or more after joint replacement operation as shown in Chart 1.

The commonest complication is:

- Dislocation of prosthesis develops in about 26.3% of cases;
- Septic pathogenesis (infection) in 14.7%;
- Periprosthetic fracture occurred in 10.3%;
- Thromboembolism in 5.3%;
- Others < 3.5 %

The complications after joint replacement occurs due to either surgical technique – method (prosthesis used) and the patient himself, who did not continue rehabilitation or did not adhere to a special physical regime after the restoration. Deterioration of the state occurs at home, when there is no close monitoring by the doctors

that was in the clinic [13, 38].

Differentiation of pain: normal or not.

Pain after endoprosthetics of the hip/knee will be observed in the early period, because the body has experienced a very serious orthopedic operation. Painful syndrome during the first 2-3 weeks is a natural response of the body to a recently transferred surgical trauma, which is not considered a deviation [10, 19]

While the operating injury does not heal, the muscle structures will not return to normal, until the bones along with the endoprosthesis become a single unit, the person will experience discomfort for a while. Therefore, prescribe a good analgesic, which helps to relieve early painful symptoms, and it is better to concentrate on therapeutic and rehabilitation exercises.

Painful sensations should be differentiated and examined whether it is a normal pain or pathological pain. This can be done by the operating surgeon. The patient's task is to notify the orthopedic doctor in case of any uncomfortable symptoms [12, 19].

Main risk factors.

Surgical intervention does not exclude complications including serious ones. Especially if mistakes were made in the intra- and/or post-operation period. Even small errors during the operation or during rehabilitation increase the likelihood of unsatisfactory arthroplasty. There are also risk factors that increase the predisposition of the body to postoperative consequences and often become their cause: advanced age of a person; severe concomitant disease (for example, diabetes mellitus, arthritic disease of rheumatoid etiology, psoriasis, lupus erythematosus; any previous operative intervention on the "native" joint, aimed at treating dysplasia, femur fractures, coxarthrosis deformities including osteosynthesis, osteotomy etc.); reendoprosthetics (repeated replacement of prosthesis); local inflammation and purulent foci in a patient's history.

It should be noted that after the replacement of the hip joints, older people are more likely to be affected by complications, especially those over 60 years. Older patients besides the underlying disease have associated pathologies that can complicate the course of rehabilitation (for example, reduce resistance to infection). There is a reduced potential for reparative-recovery functions, weakness of the musculoskeletal system, osteoporotic symptoms and lymphovenous insufficiency of the lower limbs [11, 27, 39].

Concept and methods of treatment of consequences.

Quick access to a doctor at the first suspi-

Causes of Joint Replacement Surgeries

57 % ■
Osteoarthritis

13 % ■
Trauma

9 % ■
Osteonecrosis

6 % ■
Osteoporosis

15 % ■
Others

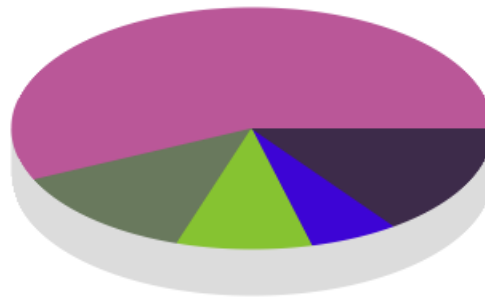


Рис. 1 (Fig. 1)

Fig. 1. Diagram.

Different reasons for a Joint Replacement Surgeries.

Рис. 1. Диаграмма.

Различные причины для операций по замене суставов.

cious signs will help to avoid the progression of undesirable phenomena, and in certain situations to save the implant without a revision operation. The more neglected the clinical picture becomes, the more difficult it will be to undergo therapeutic correction [5, 18].

Dislocations and subluxations of the endoprosthesis.

This is a leading pathological condition in which the femoral component is displaced with respect to the acetabular element in a hip replacement surgery, as a result of which the head and the cup of the endoprosthesis are uncoupled. Provocative factors are excessive loads, errors in the selection of the model and installation of the implant (defects in the angle of the setting), the use of a back surgical approach, injuries. The risk group includes people with hip fractures, dysplasia, neuromuscular pathologies, obesity, joint hypermobility, Ehlers danlos syndrome, patients older than 60 years [15, 19, 29]. Also vulnerable to dislocation are those who have undergone surgery in the past on natural arthroplasty. Dislocation requires non-surgical insertion or open method. With timely treatment, the endoprosthetic head can be fixed under anesthesia in a closed way. If the problem is triggered, the doctor may prescribe a re-operation to reinstall the endoprosthesis [12, 16, 40, 44].

Periprosthes infection

The second most frequent phenomenon, characterized by the activation of severe purulent-inflammatory processes in the area of the im-

plant. Infectious antigens enter intraoperatively through insufficiently sterile surgical instruments (rarely) or after intervention through the bloodstream move from any problem organ that has a pathogen-microbial environment (often). Poor treatment of the wound zone or poor healing (with diabetes) also contributes to the development and reproduction of bacteria as shown in Fig. 3. Purulent foci adversely affect the strength of fixation of the endoprosthesis, causing its loosening and instability. The pyogenic microflora is difficult to treat and, as a rule, involves the removal of the implant and the re-installation after a long time. The main principle of treatment is a test for establishing the type of infection, long antibiotic therapy, abundant lavage of the wound with anti-septic solutions [4, 16, 42].

Thromboembolism (PE)

PE - a critical blockage of the branches or main trunk of the pulmonary artery by a severed thrombus, which was formed after implantation in the deep veins of the lower limb due to low circulation, which resulted from limited mobility of the leg. The culprits of thrombosis are the absence of early rehabilitation and the necessary medication, a prolonged stay in an immobilized state.

The patient is immediately hospitalized in the intensive care unit, where, taking into account the severity of the thrombotic syndrome: the introduction of thrombolytics and drugs that reduce blood clotting, ventilation and embolectomy are considered [7, 16, 28].

Periprosthetic fracture.

Chart №1. Statistics of complications according to the terms after the operation.

Short term (1-8 weeks)	Midterm (2-12 months)	Long term(1-5 years)
Infection	Peri-implant bony -	Pain (complex regional pain syndrome)
Dislocation	fracture	Particle disease
Subluxation	Aseptic loosening	Component migration
Haematoma	AVN bone	Prosthesis fracture
Bleeding/wound	Thromboembolism	Heterotopic ossification
Cellulitis	Stiffness joints	Limb shortening/ lengthening
Septic loosening		
Neuropathy		

This is a violation of the integrity of the femur in the leg zone with an unstable and stable prosthesis that occurs intra-operatively or at any time after the operation (in a few days, months or years). **Fractures** are more likely to occur due to a decreased density of bone tissue, but may be a result of incompetent bone marrow development before installing an artificial joint. Therapy, depending on the type and severity of the damage, involves using one of the methods of osteosynthesis [7, 16, 37].

Neuropathy.

Neuropathic syndrome is a lesion of the peroneal nerve entering the structure of a large sciatic nerve, which can be caused by lengthening of the leg after prosthetics, pressure of the formed hematoma to nerves or nerve plexuses, less often intraoperative damage due to careless actions of the surgeon. Nerve repair is performed through etiologic treatment using the optimal method of surgery or with the help of physical rehabilitation [15, 38].

Preventive measures.

Complications after prosthetics of the hip/knee joint are much easier to prevent than to engage in time-consuming and long-term treatment to get rid of them. Unsatisfactory development of the situation can spoil all efforts of the surgeon. Therapy does not always give a positive effect and the expected result, therefore in the leading **clinics** a comprehensive perioperative program of prevention of all existing consequences is provided [21, 25, 31]. At the preoperative stage, the diagnosis for infections in the body, diseases of internal organs, allergies, etc. is performed. If inflammatory and infectious processes are detected, chronic diseases in the stage of decompensation, operational measures will not begin until the identified foci of infections are cured, venous-vascular problems will not be reduced to an acceptable level, and other ailments will not lead to a state of stable remission [22, 43]. If there is a predisposition to allergic reactions, this fact is investigated and taken into consideration, as the choice of medications, materials of the endoprosthesis and the type of anesthesia depend on it [15,

19, 41]. On the assessment of the health of internal organs and systems, age criteria and weight, the entire surgical process and further rehabilitation are under evaluation.

To minimize the risks of complications after hip/knee joint prosthetics, prevention is performed before and at the time of the procedure, after the operation, including the long-term period. Integrated preventive approach is medical elimination of the infectious source, full compensation of chronic ailments; administration of specific doses of low molecular weight heparins in 12 hours to prevent thrombotic events, antithrombotic therapy continues for some time after surgery; application for a couple of hours before the forthcoming replacement of arthroplasty and for several days of broad-spectrum antibiotics active against a large group of pathogens; impeccable technical maintenance of the operative intervention, while minimally traumatic, avoiding significant blood loss and the appearance of bruising; the selection of an ideal prosthetic construction that completely coincides with the anatomical parameters of the present bone joint, including its correct fixation at the correct orientation angle, which in the future will guarantee the stability of the implant, its integrity and excellent functionality; early activation of the ward to prevent stagnant processes in the leg, atrophy of muscles and contractures, inclusion from the first day of exercising exercise and physiotherapy procedures (electromyostimulation, magnetotherapy etc.), respiratory exercises and quality care for the operating wound; inform the patient of all possible complications, permitted and unacceptable types of physical activity, precautionary measures and the need to regularly perform exercises of physical therapy. The patient should realize that not only the degree of professionalism of doctors depends on the outcome of the operation and the success of the restoration, but also of himself. After prosthetics of the hip joint, undesirable complications are avoided by the side, but only if the recommendations of specialists are carried out impeccably [11, 19, 25].

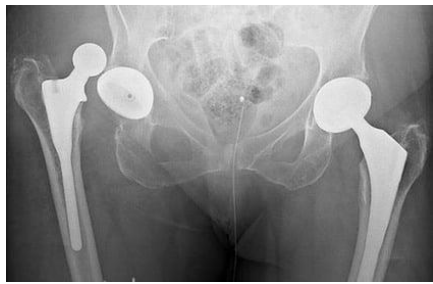


Fig. 1 (Рис. 1)

Fig. 1. X-ray, hip joints, AP view.

Dislocation of right sided hip prosthesis after 2 months of surgery.

Рис. 1. Рентгенограмма тазобедренных суставов, прямая проекция.

Отмечается дислокация протеза правого тазобедренного сустава через 2 месяца после операции.



Fig. 2 а (Рис. 2 а)



Fig. 2 б (Рис. 2 б)

Fig. 2. X-ray.

Knee joint, AP and lateral views. Joint after athroplasty; however, after 6 months post-surgery - increased bone density at lower femoral and upper tibial condylar aspect suggestive of infection.

Рис. 2. Рентгенограммы коленного сустава, прямая и боковая проекции.

Состояние после артропластики. Через 6 месяцев после операции отмечается разряжение костной ткани в области бедренного надмыщелка и большеберцового мыщелка, подозрительное на инфекционный процесс.



Fig. 3 а (Рис. 3 а)



Fig. 3 б (Рис. 3 б)

Fig. 3. X-ray, left hip joint, AP view. Axial view.

Left hip joint prosthetic fracture with a 2 years interval between the two X-rays.

Рис. 3. Рентгенограмма левого тазобедренного сустава, прямая проекция.

Перелом протеза левого тазобедренного сустава. Интервал между исследованиями – 2 года.

References:

1. Siegel R., Naishadham D., Jemal A. *Cancer statistics. CA Cancer J Clin* 2013; 63: 11–30.
2. Кравец О.А., Кузнецов В.В., Морхов К.Ю., Нечушкина В.М., Новикова Е.Г., Новикова О.В. и др.: Клинические рекомендации – рак тела матки. Москва 2017: 6-7.
3. Каприн А.Д., Старинский В.В., Петрова Г.В.: Злокачественные заболевания в России в 2014 году (заболеваемость и смертность), 2016. Москва, РИИС ФИАН 2018: 12,16,135,138.
4. Atri M., Zhang Z., Dehdashti F., Lee S.I., Helga M., Ali et al.: *Utility of PET/CT to Evaluate Retroperitoneal Lymph Node Metastasis in High-Risk Endometrial Cancer: Results of ACRIN 6671/GOG 0233 Trial* 2017. *Radiology* 2017; 283(2): 450-459.
5. Koskas M., Rouzier R., Amant F. *Staging for endometrial cancer: the controversy around lymphadenectomy – can this be resolved? Best. Pract. Res. Clin. Obstet. Gynaecol.* 2015; 29 (6): 845–857.
6. Horowitz N.S., Dehdashti F., Herzog T.J., Rader J.S., Powell M.A., Gibb R.K. et al. *Prospective evaluation of FDG-PET for detecting pelvic and para-aortic lymph node metastasis in uterine corpus cancer. Gynecol Oncol.* 2004; 95 (3): 546–51.
7. Lewin S.N., Herzog T.J., Barrena Medel N.I. *Comparative performance of the 2009 international Federation of gynecology and obstetrics staging system for uterine corpus cancer. Obstet. Gynecol.* 2010; 116 (5): 114-197.
8. Creasman W.T., Odicino F., Maisonneuve P. *Carcinoma of the corpus uteri. FIGO 26th Annual Report on the Results of treatment in Gynecological Cancer. Int J Gynaecol Obstet* 2006; 95: 105.
9. Edge S.B., Compton C.C. *American Joint Committee on Cancer: Corpus Uteri. AJCC Staging Manual, ed 7. New York, Springer; 2010: 403.*
10. American College of Obstetricians and Gynecologists: *ACOG practice bulletin, clinical management guidelines for obstetrician-gynecologists, management of endometrial cancer. Obstet Gynecol; 2005: 413–425.*
11. Benedetti Panici P., Basile S., Maneschi F., Alberto Lissoni A., Signorelli M., Scambia G. et al. *Systematic pelvic lymphadenectomy vs. no lymphadenectomy in early-stage endometrial carcinoma: randomized clinical trial. Cancer Inst.* 2008;100 (23): 1707-1716.
12. Kitchener H., Swart A.M.C., Qian Q., Amos C., Parmar M.K.B. *Efficacy of systematic pelvic lymphadenectomy in endometrial cancer (MRC ASTEC trial): a randomised study. Lancet.* 2009;373(9658): 125-136.
13. Chao A., Chang T.C., Koon-Kwan Ng., Swee Hsueh, Huei-Jean Huang, Hung-Hsueh Chou et al: *18F-FDG PET in the management of endometrial cancer. Eur J Nucl Med Mol Imaging,* 2006; 33 (1): 36-44
14. Sugiyama T., Nishida T., Ushijima K.: *Detection of lymph node metastasis in ovarian carcinoma and uterine corpus carcinoma by preoperative computerized tomography or magnetic resonance imaging. J Obstet Gynaecol,* 1995;21 (6): 551–556.
15. Rockall A.G., Sohaib S.A., Harisinghani M.G., Babar S.A., Singh N, Jeyarajah A.R. *Diagnostic performance of nanoparticle - enhanced magnetic resonance imaging in the diagnosis of lymph node metastases in patients with endometrial and cervical cancer. J Clin Oncol* 2005: 2813–2821.
16. Faria S., Sagebiel T., Devine C., Lal C., Balachandran A., Bhosale P. *Imaging in endometrial carcinoma. Indian J Radiol Imaging.* 2015; 25 (2): 137.
17. Ben-Shachar I., Vitellas K.M. CD. *The role of MRI in the conservative management of endometrial cancer. Gynecol Oncol.* 2004; 93 (1): 233-237.
18. Connor J.P., Andrews J.I., Anderson B. B.R. *Computed tomography in endometrial carcinoma. Obstet Gynecol.* 2000; 95 (5): 692-696.
19. Koskas M., Rouzier R., Amant F. *Staging for endometrial cancer: the controversy around lymphadenectomy – can this be resolved? Best Pract Res Clin Obstet Gynaecol* 2015; 29: 845–857.
20. Suzuki R., Miyagi E., Takahashi N. *Validity of positron emission tomography using fluoro-2-deoxyglucose for the preoperative evaluation of endometrial cancer. IntJGynecolCancer,* 2007;17(4): 890-896
21. Kitajima K., Murakami K., Yamasaki E., Fukasawa I., Inaba N., Kaji Y., Sugimura K. *Accuracy of 18F-FDG PET/CT in detecting pelvic and paraaortic lymph node metastasis in patients with endometrial cancer. AJRAMJ Roentgenol,* 2008; 190 (6): 1652-1658.
22. Kim H.G., Cho A., Yun M., Kim Y., Kang W.J. *Comparison of FDG PET/CT and MRI in lymph node staging of endometrial cancer. Annals of Nuclear Medicine,* 2016; 30 (2): 104–113.
23. Bestvina C.M., Fleming G.F. *Chemotherapy for endometrial cancer in adjuvant and advanced disease settings. Oncologist,* 2016; 21(10): 1250–1259.
24. Li H., Wu X., Cheng X. *Advances in diagnosis and treatment of metastatic cervical cancer. J Gynecol Oncol,* 2016; 27 (4): 43.
25. Gee M.S., Atri M., Epid D., Bandos A.I., Mannel R.S., Gold M.A. et al. *Identification of Distant Metastatic Disease in Uterine Cervical and Endometrial Cancers with FDG PET/CT: Analysis from the ACRIN 6671/GOG 0233 Multicenter Trial. Radiology* 2018; 1: 1-9.
26. Kakhki V.R., Shahriari S., Treglia G. *Diagnostic performance of fluorine 18 fluorodeoxyglucose positron emission tomography imaging for detection of primary lesion and staging of endometrial cancer patients: systematic review and meta-analysis of the literature. Int J Gynecol Cancer,* 2013; 23 (9): 1536–1543.
27. Crivellaro C., Signorelli M., Guerra L., De Ponti E., Pirovano C., Fruscio R. et al: *Tailoring systematic lymphadenectomy in high-risk clinical early stage endometrial cancer: the role of 18F-FDG PET. Gynecol Oncol,* 2013; 130: 306.
28. Atakul B.K., Taşkın S., Soydal C., Sukur Y.E., Kahraman A., Koyuncu K. et al. *Preoperative 18 F-Fluorodeoxyglucose Positron Emission Tomography/CT in Prediction of Uterine Risk Factors and Lymph Node Metastasis: An Analysis of 111 Endometrioid Endometrial Cancer Patients. Gynecol Obstet Invest,* 2017; 22; 82 (4): 340-348.
29. Hillner B.E., Siegel B.A., Shields A.F. *Relationship between cancer type and impact of PET and PET/CT on intended management: findings of the national oncologic PET registry. J Nucl Med;* 2008; 49 (12): 1928–1935.
30. Park J.Y., Kim E.N., Kim D.Y. *Comparison of the validity of magnetic resonance imaging and positron emission tomography/computed tomography in the preoperative evaluation of patients with uterine corpus cancer. Gynecol Oncol,* 2008;108 (3): 486–492.
31. Kitajima K., Murakami K., Yamasaki E., Kaji Y., Sugimura K.

Accuracy of integrated FDGPET/contrast-enhanced CT in detecting pelvic and paraaortic lymph node metastasis in patients with uterine cancer. *Eur Radiol*, 2009; 19 (6): 1529–1536.

32. Husby J.A., Reitan B.C., Biermann M., Trovik J., Bjørge L., Magnussen I.J. et al. Metabolic tumor volume on 18F-FDG PET/CT improves preoperative identification of high-risk endometrial carcinoma patients. *J Nucl Med*, 2015; 56 (8): 1191–8.

33. Liu F.Y., Chao A., Lai C.H., Chou H.H., Yen T.C. Metabolic tumor volume by 18 F-FDG PET/CT is prognostic for stage IVB endometrial carcinoma. *Gynecol Oncol*. 2012; 125 (3): 566–71.

34. Kitajima K., Kita M., Suzuki K., Senda M., Nakamoto Y., Sugimura K. Prognostic significance of SUVmax (maximum standardized uptake value) measured by [18F]FDG PET/CT in endometrial cancer. *Eur J Nucl Med Mol Imaging*, 2012; 39 (5): 840–5.

35. Walentowicz-Sadlecka M., Malkowski B., Walentowicz P., Sadlecki P., Marszalek A., Pietrzak T. et al. The preoperative maximum standardized uptake value measured by 18F-FDG PET/CT as an independent prognostic factor of overall survival in endometrial cancer patients. *Biomed Res Int*, 2014; 2014: 110-14.

36. Kang S.Y., Cheon G.Y., Lee M., Kim H.S., Kim J., Park H. et al. Prediction of Recurrence by Preoperative Intratumoral FDG Uptake Heterogeneity in Endometrioid Endometrial Cancer. *Translational oncology* 10(2):178-183

37. Antonsen S.L., Loft A., Fisker R., Nielsen A.L., Andersen E.S., Hogdall E. et al. SUVmax of 18FDG PET/CT as a predictor of high-risk endometrial cancer patients. *Gynecol Oncol*, 2013; 129: 298–303.

38. Yahata T., Shigetaka Y., Yasushi M., Yuko T., Aya K. Prognostic impact of primary tumor SUVmax on preoperative 18F-fluoro-2-deoxy-D-glucose positron emission tomography and computed tomography in endometrial cancer and uterine carcinosarcoma. *Molecular and clinical oncology*, 2016; 5 : 467-474.

39. Солопова А.Е., Терновой С.К., Макацария А.Д., Гуров С.Н. Возможности диффузионно-взвешенных последовательностей МРТ в оценке эффективности неоадьювантной химиотерапии больных раком яичника. *Russian Electronic Journal of Radiology*, 2016; 6 (4): 68-80.

40. Saga T., Higashi T., Ishimori T. et al. Clinical value of FDG-PET in the follow up of post-operative patients with endometrial cancer. *AnnNucl Med*, 2003;17(3): 197-203.

41. Kitajima K., Murakami K., Yamasaki E. Performance of 18F-FDG- PET/CT in the diagnosis of recurrent endometrial cancer. *AnnNuclMed*, 2008; 22 (2): 103-109.

42. Bollineni V.R., Ytre-Hauge S., Bollineni-Balabay O, Salvesen HB, Haldorsen IS. High diagnostic value of 18F-FDG PET/CT in endometrial cancer: systematic review and meta-analysis of the Literature. *J Nucl Med* 2016;57(6): 879-85

43. Suga T., Nakamoto Y., Saga T. et al. Clinical value of FDG-PET for preoperative evaluation of endometrial cancer. *Ann Nucl Med*, 2011; 25(4):269–75.

44. Haldorsen I.S., Salvesen H.B. What is the best preoperative imaging for endometrial cancer? *Curr Oncol Rep*, 2016; 18: 25.