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## Direct anterior surgical approach for total hip arthroplasty as an alternative to the direct lateral approach

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*The frequency of total hip arthroplasty (THA) is continuously increasing. Currently, efforts are underway to improve the efficiency of this surgery, making the choice of surgical approach a key factor in its success. The direct anterior approach is gaining popularity due to faster patient recovery, but its advantages and disadvantages compared to the direct lateral approach are not yet fully understood. Objective. To compare the outcomes of the direct anterior and direct lateral approaches in primary total hip arthroplasty, as well as to identify ways to improve the results of THA performed using the direct anterior approach. Methods. A literature search was conducted in three bibliographic databases: PubMed, Scopus, and Web of Science. Results. The direct anterior approach has been found to reduce postoperative pain, blood loss, the likelihood of periprosthetic infection, and hospital stay duration. However, there is an increased risk of dislocation and revision surgery. Several randomized controlled trials have been cited, studying issues related to effective pain management, wound healing, prevention of lateral femoral cutaneous nerve injury, blood loss, prosthetic stem design, specific surgical techniques, equipment selection, early mobilization after THA, and the use of modern software for THA planning. Conclusions. The literature review revealed that patients who underwent THA via the direct anterior approach experienced less postoperative pain. The shorter incision associated with this approach also reduces intraoperative blood loss and periprosthetic infection rates. However, the risk of dislocation and subsequent revision surgeries increases, as does the incidence of nerve paralysis due to lateral femoral cutaneous nerve injury.*

*Частота виконання тотального ендопротезування кульшового суглоба (ТЕКС) постійно зростає. Наразі триває пошук способів підвищення ефективності цієї операції, тому вибір хірургічного доступу є визначальним чинником її результативності. Прямий передній доступ стає все більш популярним унаслідок швидкого відновлення пацієнтів, але повністю не з'ясовано його недоліки чи переваги відносно прямого латерального. Мета. Порівняти результати використання прямих переднього та латерального доступів для первинного тотального ендопротезування кульшового суглоба, а також з'ясувати способи покращення результатів виконання тотального ендопротезування кульшового суглоба під час прямого переднього доступу. Методи. Пошук літератури проведено в трьох бібліографічних базах: PubMed, Scopus та Web of Science. Результати. Виявлено, що застосування переднього доступу дозволяє знизити післяопераційний біль, крововтрату, ймовірність перипротезної інфекції, тривалість перебування в лікарні. Проте існує ризик вивиху головки ендопротеза та ревізійних втручань. Наведено висновки декількох рандомізованих контрольованих досліджень, у яких вивчали питання ефективного знеболення, способів сприяння загоєнню рани, запобігання ушкодженню бічного шкірного нерва стегна, крововтрати, дизайну ніжки ендопротеза, особливостей хірургічної техніки та вибору обладнання для використання цього доступу, ранньої мобілізації пацієнта після ТЕКС, застосування сучасних програмних засобів для планування ТЕКС. Висновок. У результаті проведеного аналізу літератури встановлено, що хворі після використання ТЕКС переднім доступом відчують менший післяопераційний біль. Також через меншу довжину розрізу в разі такого доступу знижується інтраопераційна крововтрата, кількість випадків перипротезної інфекції; проте зростає ризик вивиху головки ендопротеза та, як наслідок, ревізійних втручань; підвищується частота нервового паралічу внаслідок ушкодження бічного шкірного нерва стегна. Ключові слова. Тотальне ендопротезування кульшового суглоба, прямий передній, прямий латеральний, біль, перипротезна інфекція, реабілітація.*

**Keywords.** Total hip replacement. direct anterior, direct lateral, pain, periprosthetic joint infection, rehabilitation

## Introduction

Total hip arthroplasty (THA) is one of the most successful surgical interventions, and its frequency, especially in developed countries, is increasing every year in accordance with the rise in the average age of the world population [1]. In the USA, the frequency of THA is predicted to increase by 176 % in 2040, and by 659 % in 2060 [2]. Mortality due to complications after primary THA is low [3], however, periprosthetic infection, periprosthetic fractures, prosthesis instability, and endoprosthetic head dislocations escalate the risk of revision intervention [4, 5]. This reduces further clinical effectiveness of THA and requires significant financial costs due to the value of the endoprosthesis [6], so the search for ways to prevent such complications continues. An important issue is the economic efficiency of THA, which partly depends on the length of the patient's stay in the hospital, as well as on the type of treatment, inpatient or outpatient, therefore the task of early mobilization of patients is actively investigated [7]. THA is a surgical procedure after which patients are often prescribed opioids due to severe postoperative pain [8]. Solving the issue of reducing their prescription is very important for studies of the effectiveness of THA in view of possible dependence on these agents. The main clinical outcome for individuals with THA is the return of hip joint functionality and improved mobility, so their satisfaction with prosthetic repair is also the subject of modern research [9]. An important factor affecting the above-mentioned features of THA is the choice of surgical access [10–14]. Recently, direct anterior access has become more popular due to less traumatization of tissues and the possibility of faster mobilization of the patient. However, there is no clear evidence of its advantages over others, in particular direct lateral [15]. In a 2020 survey of 71 members of the Hip Society, 49 % had used the direct anterior approach during their surgical practice, of whom almost half were not using it at the time of the survey, while 78 % felt that the advantage of this approach over others had not been proven [16].

*Purpose:* To compare the results of using direct anterior and direct lateral approaches for total hip arthroplasty, and to identify ways to improve the results of total hip arthroplasty in direct anterior approach based on the analysis of the results of randomized controlled trials.

## Material and methods

Literature was searched in three bibliographic databases: PubMed, Scopus and Web of Science. The search query consisted of the following key-

words: Arthroplasty, Replacement, Hip [Mesh], total hip arthroplasty, total hip replacement, direct approach, direct anterior approach, lateral approach, transgluteal lateral approach. We searched for randomized controlled and comparative trials, meta-analyses and systematic reviews written in English in the last 5 years. 211 sources of literature were found, of which 50 remained after removing duplicates and irrelevant articles — 17 systematic reviews, 12 comparative studies, 21 randomized controlled trials (RCTs).

## Results and their discussion

### *Comparison of the results of using direct anterior or direct lateral approaches*

*Pain.* It is believed that during the anterior approach there is less muscle damage and, accordingly, less pain, but these issues are still being investigated. According to the data of the systematic review [17], which is currently the only one on this issue, where 5 RCTs analyzed the possibilities of using blood serum markers to assess the features of the muscle condition under the conditions of various surgical approaches for THA, it was not possible to prove their clinical significance (Table 1). In one of the RCTs from this review, R. Iorio et al. [18] (n = 70) studied the following serum markers: myoglobin, creatine kinase MB, troponin I, C-reactive protein, and hemoglobin on days 1, 3, and 5 after THA to assess muscle damage. Pain intensity was also analyzed using the visual analog scale (VAS). They did not find a difference between the indicators depending on the type of access, although pain was less in the group of patients with anterior at 2, 3 and 5 days [18]. In another RCT (n = 120), which investigated the effect of obesity on the results of THA, depending on the surgical approach, G. Macheras et al. [19] also recorded greater pain according to the Face Pain Scale-Revised and reduced quality of life according to the modified Harris scale in patients with lateral access without obesity at 6 and 12 weeks, and with obesity at 6 weeks after THA. At the same time, in patients with anterior access, the presence of obesity did not affect the results of THA [19].

In a retrospective cohort study, S. Seah et al. [20] evaluated the use of opioids after THA with local infiltration analgesia in subjects with anterior (n = 179) or lateral (n = 178) access. In an anterior access pain was found to be less and, accordingly, the daily dose of opioid use was 21 % lower compared to the group with a lateral approach [20]. Two years after THA, 88 patients with an anterior approach in a prospective cohort study had less pain on the VAS, better

functional outcomes according to the modified Harris scale, and greater satisfaction with THA than with a lateral approach ( $n = 26$ ) [10].

In two systematic reviews, it is stated that in the case of anterior access, pain is less on the VAS scale in the early days after THA, than in the case of lateral access [12, 13] (Table 1). In one of them, pain in patients with an anterior approach was lower on the first day [12], and in the other 2 days and 2 weeks after THA [13].

*Complications.* The risk of their development, associated with the healing of the wound from the incision, under the conditions of direct anterior access is probably higher compared to the lateral one, due to the location of the incision in the fold of the body and subsequent complications with hygiene. Because of this, K. D. Carlock et al. [69] in a prospective study compared the possibility of such complications in patients with anterior ( $n = 579$ ) or lateral ( $n = 167$ ) access within 6 weeks after THA and found no difference, but individuals with a high body mass index (BMI) who had higher risk of such complications prevailed in the group with lateral access. In a systematic review by X.-T. Huang et al. [42] also found no difference in the rate of postoperative wound infection depending on access, but patients from the studies included in the review had a BMI of less than 35 (Table 1). The lower risk of infection, regardless of the location of the incision, during the anterior approach may be related to its shorter length compared to the lateral one, which is shown in a systematic review of 7 RCTs [12] (Table 1).

In an observational retrospective study ( $n = 150$ ) with an equal distribution of patients in groups with two different accesses, a greater number of early serious complications (40 vs. 12 %) were found in individuals with lateral, among which motor neurological ones prevailed, but functional results according to the Harris scale did not differ for 90 days of observation [70]. A higher risk of major surgical complications in the first year after THA in the case of an anterior approach was confirmed in a large-scale retrospective cohort study, which analyzed the results of arthroplasty performed in Canada in 2015–2018, of which 2,995 cases were with an anterior approach, 21,248 were with a lateral approach [71]. Among them were the following: deep infection; dislocation of the endoprosthesis head, which requires surgical intervention; revision THA [71]. However, in a meta-analysis that included 115,266 patients with a lateral approach and 61,158 with an anterior approach, A. Acuna et al. [21] found a lower frequency of periprosthetic infection for the anterior approach

(0.50 vs. 0.97 % of cases) compared to the lateral approach (Table 1).

One systematic review included 15 studies, of which 5 compared lateral and anterior approaches. C. O'Connor et al. [65] found no difference in the incidence of superficial or deep infection for the anterior approach compared with all others (lateral, posterior, anterolateral, acetabulum) (Table 1). This information requires confirmation and further study, as with the comparison with the lateral approach. Scientists X.-T. Huang et al. [42] also found no difference between lateral and anterior approaches in the incidence of superficial infection.

In the case of anterior access, compared to lateral access, according to the data of the systematic review, the frequency of periprosthetic fractures is higher (1.05 vs. 0.41 % of 6,953 and 9,173 cases), as well as loosening of endoprosthesis components (0.61 vs. 0.37 % of 7,019 and 9,237 episodes), postoperative dislocation of the prosthetic head (0.77 vs. 0.18 % of 8,905 and 14,203 cases), neurological disorders (0.95 and 0 % of 1,478 and 568 episodes) [42] (Table 1). At the same time, [42] found no difference in the frequency of revision THA depending on the type of access, but the advantages of the anterior, in their opinion, were a lower frequency of incorrect placement of the prosthesis, fewer discrepancies in the length of the lower limbs and minor muscle damage. However, F. Migliorini et al. [64] in a network meta-analysis showed worse alignment of the femur for the anterior approach, and worse anteversion of the prosthesis cup for the lateral approach (Table 1). According to the results of another study, there is no difference in the size of the angle of abduction of the cup or the angle of anteversion of the cup depending on the type of access [67]. F. Migliorini et al., contrary to the results of X. Huang et al., showed that the frequency of postoperative dislocation of the endoprosthesis head is greater for the lateral approach, and the frequency of revisions and nerve palsy for the anterior one [56].

A greater risk of neurological disorders in the case of an anterior approach was also confirmed in a study of 20 cadavers, where damage to the lateral femoral cutaneous nerve (LFCN) occurred in 65 % of the cases of the anterior approach and 30 % of the lateral approach [72]. In this experiment, it was possible to reduce the frequency of injury to the cranial nerve during anterior access by 25 % due to a reduction in the length of the proximal incision by 10 mm [72].

In two systematic reviews, no difference in the number of complications was recorded de-

Table

**Characteristics of systematic reviews that analyzed clinical and functional outcomes after THA**

Author	Number of patients			Country where the study was performed	Studies analyzed in a systematic review comparing direct anterior and direct lateral approaches
	direct anterior access	direct lateral access	total		
Acuña A. et al. [21]	61 158	115 266	176 424	Australia, Netherlands, Norway, USA, Switzerland	RCT [22] Non-RCT [14, 23–29]
Ang J. et al. [30]	659	682	1 341	Spain, Canada, Germany, Norway, Romania, USA, Sweden	RCT [22, 31–40]
Gazendam A. et al. [13]	390	383	773	Spain, Canada, Germany, Norway, USA, Sweden	RCT [22, 31, 33, 37, 39–41]
Huang X.-T. et al. [42]	9 913	10 599	20 512	Italy, Canada, Norway, USA, Switzerland	RCT [22, 32, 39, 40] Non-RCT [14, 26, 27, 43–46]
Kim A. et al. [47]	4 874	2 245	7 119	Canada, China, Netherlands, Germany, Norway, USA	RCT [22, 33, 39] Non-RCT [9, 48–54]
Kucukdurmaz F. et al. [12]	332	360	692	Austria, Spain, Germany, Norway, Romania, USA	RCT [33–36, 39, 41, 55]
Migliorini F. et al. [56]	714	752	1 466	Austria, Canada, Germany, Norway, Switzerland	RCT [22, 34, 37] Non-RCT [46, 57–63]
Migliorini F. et al. [64]	370	412	782	Italy, Germany, Switzerland	RCT [34, 37] Non-RCT [46, 59, 60, 63]
O'Connor C. et al. [65]	7 713	4 191	11 904	USA, Switzerland	Non-RCT [14, 23, 26, 27, 66]
Sarantis M. et al. [17]	252	252	504	Spain, Italy, Norway, Romania	RCT [18, 33, 35, 36, 38]
Yan L. et al. [67]	426	448	871	Australia, Austria, Spain, Germany, Norway, Romania, USA, Sweden	RCT [22, 31, 33, 34, 36, 37, 41, 55, 68]

Note. RCT — randomized controlled study, non-RCT — clinical studies of another type: non-randomized prospective, retrospective, cohort, case-control studies.

pending on the type of access [30, 67] (Table 1). In a systematic review, J. Ang et al. (11 RCTs) found no higher risk of neuropraxia, venous thromboembolism, periprosthetic fractures, and dislocations for anterior access. L. Yan et al. also found no difference in complication rates comparing access types in a systematic review of 9 RCTs, but the volume of blood loss was lower during anterior than lateral. At the same time, T. Kawano et al. showed a greater risk of venous thromboembolism under conditions of anterior access (7 versus 4 cases). [73] in a retrospective multicenter study (116 hip joints: 36 — anterior, 80 — lateral approach). According to the authors, the obtained results may be related to the duration of use of the anterior access in the clinic, because due to the introduction of the new access, the operation time increases, which increases the risk of further occurrence of venous thromboembolism [73]. This is confirmed in a systematic review, where the authors analyzed the effect of surgeon training on the frequency of complications and found that it was re-

duced by  $\approx 2.7$  times and the duration of surgical intervention by  $\approx 1.8$  times in doctors who performed 100 THAs through an anterior approach, compared to less experienced ones (1–30 arthroplasty) [74]. At the same time, J. Ang et al. in the systematic review found no differences regarding the duration of THA depending on the type of access (Table 1).

*Functional results.* A systematic review of 11 RCTs for the anterior approach reported better functional outcomes as assessed by the Harris scale compared to the lateral at 12 weeks (84 days), but there was no difference 6 weeks (42 days) and one year after THA [30]. Opposite data were obtained in two systematic reviews, where 7 RCTs were analyzed each, and after 6 weeks, better indicators were found for anterior access according to the Harris scale [12, 13], as well as according to WOMAC [12] (Table 1). In a systematic review, L. Yan et al. [67] confirmed better results according to the Harris scale for the anterior approach compared to the lateral approach for  $\approx 1.3$  years (follow-up duration in RCTs from 3 months to 5 years).

Despite the large number of clinical studies conducted to compare the effectiveness of using different surgical approaches during THA, in a recent systematic review by A. Kim et al. [47] could not draw clear conclusions about the differences between the front and the others when evaluating the clinical results according to the scales of Harris, VASH, HOOS, OHS, FJS-12, WOMAC (Table 1). Only for EQ-5D was noted a significant advantage in favor of anterior access [47].

In a long-term comparative study 5 years after THA, no difference was found in the functional results assessed by the HOOS and WOMAC scales, depending on the use of lateral (n = 104) or anterior approaches (n = 125) [49].

Contradictory clinical results of systematic reviews may be explained by the need to consider not only the level of significance P, but also the inverse fragility index proposed by M. Gonzalez et al. for the analysis of the results. It involves calculating the number of cases, the addition of which would make the result significant. After that, the inverse coefficient of fragility is calculated by dividing the index by the size of the study sample. A moderate fragility coefficient was found in many RCTs that compared the anterior approach with others, which, according to the authors, indicates a possible lack of difference in the obtained results [75].

There are conflicting data regarding the length of hospital stay. Thus, systematic reviews report both a shorter duration [13] and no difference [30] for patients with anterior versus lateral access (Table 1). Interestingly, a systematic review by L. Yan et al. [67] found a decrease in hospital length of stay in newer publications compared to older ones, possibly due to changes in the healthcare system.

The economic efficiency of THA depending on the type of surgical access is also a subject of research. In a recent systematic review, which analyzed data from 5 studies on this issue, the authors did not draw precise conclusions due to the insufficient amount of information to date [76].

Few studies have been conducted to compare the results of using prosthetic legs of different designs depending on the type of access. A comparative study by S. Heaven et al. [77] showed the same effectiveness of using the legs of prostheses with hydroxylapatite coating and a collar during 2 years of follow-up regardless of the type of surgical access in 695 patients (anterior — 281, lateral — 497 hip joints).

*Ways to improve THA results when using direct anterior access*

Above, we analyzed the results of using direct anterior and direct lateral approaches for THA and

found that there are still conflicting data regarding the effectiveness of direct anterior access. Several RCTs have been devoted to solving problems of pain, postoperative complications, technique and equipment for access, speed of patient mobilization, design of prostheses for this access.

*Pain.* In the early postoperative period, in patients with spinal anesthesia after THA with anterior access, local infiltration analgesia reduces pain sensations (determined by VAS) after 3 and 4 hours but does not cancel the urgent administration of opioids [78]. At the same time, the use of *fascia iliaca compartment* blockade with spinal anesthesia allows to reduce the frequency of prescribing these agent in the first 24 hours after prosthetic repair compared to local infiltration analgesia [79]. Another approach to reducing pain after THA is the administration of oral or intravenous pain relievers.

A comparison of the effects of oral tramadol/dexketoprofen with intravenous paracetamol and tramadol in an RCT involving 132 patients who underwent THA through a minimally invasive anterior approach showed higher efficacy in reducing pain (VAS) in the first 48 hours [80].

*Complication.* Direct anterior access during THA may increase the risk of complications during surgery, so various researchers are looking for ways to prevent them. One of them is the use of negative pressure therapy with a closed incision, particularly in patients with an increased risk of complications: BMI > 30 kg/m<sup>2</sup>, diabetes, active smoking. The use of this therapy reduced the frequency of complications, both superficial and general in patients, compared to the same number of people without the use of therapy: 8.3 versus 18.3 % of cases, respectively [81].

The most common complication under the conditions of anterior surgical access is damage to the LFCN, especially if a “bikini” incision is made. This is confirmed by the results of an RCT, in which injury to this localization was found depending on the type of incision (longitudinal or “bikini”) in 195 patients using ultrasound [82]. The authors recorded a higher frequency of such an injury in patients with a “bikini” incision, and most often of the anterior trunk of the LFCN (56 % of cases or 32 individuals). The method of prevention of this complication is the arrangement of fasciotomy. This can play a special role when the LFCN is fan-shaped — the nerve branches radially, which increases the risk of its damage under the conditions of performing THA through an anterior approach using a conventional fasciotomy [83]. H. Tanabe et al.

[84] in an RCT compared the use of conventional or lateral fasciotomy in 134 patients with non-fan-like type of LFCN and found no difference between the groups in the frequency of nerve damage after 3 months of observation.

Another effective way to prevent injury to the thoracic spine is to conduct a preoperative ultrasound examination of its 3D location, which was performed within 3 months of observation of 58 people compared to a group of patients (n = 58) who did not undergo it before THA [85].

The use of the “bikini” incision compared to the traditional longitudinal one has advantages in evaluating the aesthetic appearance of the scar according to the SCAR scale [52]. Other postoperative outcomes, such as proinflammatory cytokine levels at 2 days after THA, implant stability at 6 weeks, VAS, Oxford Hip Assessment, and UCLA scores within 6 months of observations did not differ in 99 RCT patients with different incisions [52].

LFCN passes in the fascia layer of the *tensor fasciae lata* muscle, its injury from retractors is also one of the complications when performing THA through the anterior approach. In one RCT, to protect this muscle, the authors created a tissue “cushion” from the anterior capsule of the hip joint, which gave better functional results on the Harris scale one month after THA, but after six months the results were the same as the group without it [86].

Blood loss is one of the serious complications of THA, regardless of the type of access, for the prevention of which tranexamic acid is used. In particular, G. Vles et al. [87] showed the effectiveness of its use to prevent blood loss regardless of the method of administration to 120 patients after anterior access: intravenously before wound closure (n = 60) or through subfascial drainage (n = 60). A placebo-controlled RCT involving 150 subjects found that the administration of carbazochrome sodium sulfonate together with tranexamic acid after THA reduced total blood loss, pain (VAS), and reduced inflammation compared with the use of tranexamic acid alone [88]. S. Ye et al. [89] obtained similar results regarding the effectiveness of the combination of tranexamic acid and carbazochrome sodium sulfonate in an RCT involving 100 patients, and proved the absence of an effect of such a combination on intraoperative blood loss, pain, and joint function.

The use of bone wax on the 3<sup>rd</sup> and 5<sup>th</sup> day is an effective way to prevent blood loss during and after THA, as proved in an RCT involving 152 subjects, 77 of whom did not use bone wax [90].

Reducing the frequency of migration of the endoprosthesis leg is an urgent issue for the use of anterior access during THA. A small RCT showed that the use of a collar is effective for the prevention of leg subsidence in the first 2 weeks after surgery in 23 patients, but from 4 to 52 weeks its use did not have significant differences according to the results of 26 patients who did not have it [91]. A systematic review (n = 6,825) showed that the use of a collared prosthesis stem or a long implant stem during anterior access can reduce the incidence of postoperative complications (neuropathia, wound infection, LFCN, hematoma, arterial injury, cup malposition, embolism, fracture and weakening of the implant) compared to a short leg without a collar or a short leg of a prosthesis, but does not affect the frequency of revision THA [92].

*Surgical technique.* The use of capsulectomy or repair of the anterior capsule of the hip joint in the case of an anterior approach gives the same clinical result in terms of postoperative pain, HOOS score, and maximum flexion angle studied radiographically and with the help of a goniometer, which was shown in an RCT of 72 patients with a follow-up period of 4 months after THA [93]. A longer study, over 5 years, also found no difference between these techniques in terms of pain level and range of motion in 98 patients after surgery [94]. In another RCT, there is no dependence of the functional results of endoprosthesis (HSS, SF-36) on the type of treatment in 190 subjects during the year [95].

Frontal access is performed with the patient lying on his back or side. A recent RCT (n = 90) found a higher number of complications within 6 months after THA in patients operated on in the supine position, among them dislocation of the head of the endoprosthesis in 2 cases, fracture of the greater acetabulum — 1, persistent fever of unknown origin — 1, poor functional hip flexion — 1, compared to the position on the side, where the dislocation was in 1 patient [96]. However, clinical (VAS, WOMAC, SF-12, Harris Hip Score, UCLA, blood loss, THA duration, hospital stay) and radiographic (prosthetic position) outcomes in this RCT did not differ between the two positions [96].

*Equipment.* In addition to the position of the patient, the type of operating table for performing THA plays an important role. A recent systematic review of 43 RCTs (n = 2,258) showed that anterior approach surgery on a traction table may reduce the risk of periprosthetic fracture but increases the volume of blood loss compared with the use of a standard table [97].

Contrary to this, another systematic review did not describe the difference in the frequency of periprosthetic fractures and dislocations of endoprosthetic heads depending on the type of operating table, showed a decrease in the number of intraoperative fractures on a standard table, and confirmed the conclusions of the above review [97] regarding blood loss and frequency of revisions [98].

**Patient mobilization.** The issue of the term of verticalization of patients after anterior access THA is the subject of modern clinical research. J. Oberfeld et al. [99] in an RCT (n = 167) considered the possibility of mobilizing patients in the first 4 hours after surgery, taking into account factors that increase the risk of complications, such as advanced age ( $\geq 75$  years), obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) and the presence severe diseases (ASA  $\geq 3$ ). Such early verticalization allows to accelerate the discharge of the patient from the hospital compared to mobilization the next day after THA without increasing the frequency of immediate side effects in patients with a high risk of their development in observation within 90 days [99].

Under the conditions of THA, outpatients are discharged on the same day. V. Zomar et al. [7] proved that outpatient (n = 49) THA is cheaper compared to inpatient (n = 56), under the conditions of anterior access intervention. Although the researchers found no difference in patient complication rates between these types of treatment, those with outpatient treatment had worse clinical outcomes as assessed by the WOMAC scale during the 12-week follow-up [7].

A promising direction for reducing the risk of complications and obtaining better functional results can be the use of programs for preoperative three-dimensional planning of THA. For one of them — AIHIP, W. Yang et al. [100] showed superior planning accuracy for acetabular and femoral prosthesis compared to patients using 2D templates (n = 220). Clinical outcomes (blood loss, operative time, limb length, Harris scale) were also better in the group (n = 220) where AIHIP was used [100].

## Conclusions

To date, randomized controlled trials have been conducted to improve the effectiveness of using the direct anterior access technique for THA. They studied the issue of effective analgesia, methods of promoting wound healing and preventing damage to the lateral cutaneous nerve of the thigh, reducing blood loss, choosing the design of the endoprosthesis leg and equipment for using this access, features of surgical technique, early mobilization of the pa-

tient, and the use of modern software tools for THA planning.

Analysis of the literature showed that the use of anterior access contributes to the reduction of postoperative pain, intraoperative blood loss, and periprosthetic infection; does not affect the frequency of superficial infection; however, it increases the risk of dislocation of the endoprosthesis head and likely revision interventions; increases the frequency of nerve palsy due to damage to the lateral cutaneous nerve of the thigh.

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

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## DIRECT ANTERIOR SURGICAL APPROACH FOR TOTAL HIP ARTHROPLASTY AS AN ALTERNATIVE TO THE DIRECT LATERAL APPROACH

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