

## ОПТИМИЗАЦИЯ ТОТАЛЬНОГО ЭНДОПРОТЕЗИРОВАНИЯ ТАЗОБЕДРЕННОГО СУСТАВА ПРИ ДИСПЛАСТИЧЕСКОМ КОКСАРТРОЗЕ

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### ✓ Резюме

Дегенеративно-дистрофические поражения тазобедренного сустава - актуальная проблема, решением которой является проведение эндопротезирования - от 100 до 300 случаев на 100000 населения в год. Асептическая нестабильность компонентов эндопротеза доминирует в среде неудовлетворительных результатов в долгосрочной перспективе. Для предотвращения асептической нестабильности компонентов протеза тазобедренного сустава при патологии тазобедренного сустава авторами предложена методика "надрезания" сухожилия т. iliopsoas и интраоперационным методом определения центра вращения головки эндопротеза. В данной работе проанализирована методика хирургического лечения 103 пациентов, оперированных традиционным способом, и 91 пациента, которым был произведен хирургический разрез т. сухожилие подвздошно-поясничной мышцы интраоперационно методом определения центра вращения головки эндопротеза

**Ключевые слова:** диспластический коксартроз, тотальное эндопротезирование тазобедренного сустава, асимметрия нижней конечности, асептическая нестабильность.

## ДИСПЛАСТИК КОКСАРТРОЗДА СОН ЧАНОҚ БЎҒИМИНИ ТОТАЛ ЭНДОПРОТЕЗЛАШНИ ОПТИМАЛЛАШ

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### ✓ Резюме

Сон-чаноқ бўғимининг дегенератив-дистрофик жароҳатланиши долзарб муаммо бўлиб, унинг ечими бир йилда 100000 аҳоли сонига 100 дан 300 тагача эндопротезлаш операцияси амалиётини бажариш орқали амалга оширилади. Узоқ муддатли натижалар ўртасида эндопротез қисмларининг асептик ностабиллиги доминантлик қилади. Сон-чаноқ бўғими патологиясида протез компонентларининг асептик ностабиллигини олдини олиш учун муаллифлар томонидан т. Iliopsoas мушаги пайини кесиш ва интероперацион сон бошчасини ўз ўқи атрофида айланиши марказини аниқлаш усулини таклиф қилинган. Мазкур ишда 103 та беморда анавивий усулда хирургик даволаш усулида ва 91 та беморда эса интероперацион сон бошчасини ўз ўқи атрофида айланиши марказини аниқлаш ва т. Iliopsoas мушаги пайини кесиш усули орқали ўтказилган операциялар таҳлил қилинган.

**Ключевые слова:** диспластик коксартроз, сон-чаноқ бўғимини тотал эндопротезлаш, пастки мучалар ассиметрияси, асептик ностабиллик.

## OPTIMIZATION OF TOTAL HIP ARTHROPLASTY FOR DYSPLASTIC COXARTHROSIS

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### ✓ Resume

Degenerative-dystrophic lesions of the hip joint are an urgent problem, the solution of which is the implementation of endoprosthesis - from 100 to 300 cases per 100,000 populations per year. Aseptic instability of the components of the endoprosthesis dominates the environment of unsatisfactory outcomes in the long term. In order to prevent aseptic instability of the components of the hip joint prosthesis in case of hip joint pathology, the authors proposed a technique for "incising" the tendon m. iliopsoas and using the intraoperative method for determining the center of rotation of the endoprosthesis head. In this work, we analyze the method of surgical treatment of 103 patients operated on in the traditional way, and 91 patients who underwent surgical incision of the m. iliopsoas tendon using the intraoperative method of determining the center of rotation of the endoprosthesis head.

**Key words:** Dysplastic coxarthrosis, total hip replacement, asymmetry of the lower limb, aseptic instability.

### Introduction

Underdevelopment of the acetabulum becomes the main reason for the development of progressive pathology of the hip joint, referred to as dysplastic coxarthrosis. And this pathology occupies a special place among orthopedic diseases in connection with a wide range of patients requiring surgical treatment. The specific gravity of dysplastic coxarthrosis, according to literature data, is 40-87% of the total pathology of the hip joint [2].

Considering that the development of arthrosis against the background of hip dysplasia is inevitable, this prompts to continue the search for solutions for the treatment of this pathology. In the main group of these patients, restoration of the supporting and motor function of the lower extremity is possible only by endoprosthesis of the hip joint [3]. Acetabular deformity is a common manifestation of diseases and injuries of the hip joint. It is characterized by the presence of defects in the walls of the acetabulum and (or) bone growths - osteophytes. A

deformed acetabulum complicates the intraoperative orientation of the acetabular component of a total hip arthroplasty, and the presence of pronounced defects reduces the possibilities of implant fixation [8, 9, 10]. The more significant the anatomical changes in the acetabulum, the more often non-standard placement of the acetabular component is required to optimize fixation [11, 12, 13, 14, 15], which leads to little predictable changes in biomechanics [16, 17, 18]. Preoperative planning of total arthroplasty in routine clinical practice is carried out using radiographs of the hip joints, performed in frontal projection. This projection is well studied, standardized, and therefore the most informative both for preoperative planning and for assessing the results of arthroplasty [1, 19]. However, there are many difficulties in achieving a stable installation of the bowl in an underdeveloped cavity [4]. An important point of endoprosthetics is that pathological anatomical relationships in dysplastic coxarthrosis require a differential approach for implantation of endoprosthesis components [5]. In hip arthroplasty, despite the improvement in the technology of surgical intervention, the quality of materials for the manufacture of implants and their design [6,7], the frequency of aseptic instability of the prosthesis is quite high [7]. The main reason for failure is aseptic loosening of the components of the endoprosthesis. The problem of aseptic instability and ways to eliminate it have been actively discussed since the 1970s [2,4]. Satisfactory outcomes in hip arthroplasty in the first years after surgery in 3% of cases are associated with technical errors, in 7% with the development of an infectious process, in 6%

with dislocation of the head of the joint. Aseptic loosening of the components of the endoprostheses occurs at a later period [2-4,7]. According to the leading orthopedic centers in 12 European countries (EUROHIP), the level of aseptic instability has practically no tendency to decrease. Aseptic instability of the endoprosthesis components dominates the environment of unsatisfactory long-term outcomes. In order to prevent aseptic instability of the components of the hip joint endoprosthesis in destructive - dystrophic lesions of the hip joint, the authors proposed a tenotomy technique for the tendon part of m. iliopsoas using the intraoperative method for determining the center of rotation of the endoprosthesis head. The article analyzes the diagnostics and features of surgical treatment of 66 patients operated on in the traditional way, and 70 patients who underwent tenotomy of the tendon of m. iliopsoas with the determination of the intraoperative center of rotation of the head with the instrument (No. FAP20190128).

Objective: To improve the results of total hip arthroplasty in dysplastic coxarthrosis.

### Materials and methods

In the department of orthopedics of the multi-disciplinary clinic of the Tashkent Medical Academy and the "Starorthomed" clinic, 136 patients were operated on for dysplastic coxarthrosis from 2017 to 2020, who were implanted with hip joint endoprostheses. There were 92 (67.8%) women and 44 (32.2%) men. The age aspect ranged from 30 to 72 years (average  $40.2 \pm 0.7$  years). (table 1).

Table 1.

Distribution of patients by sex and age

floor	Age groups										Total	
	31-40		41-50		51-60		61-70		71-80		abs.	%
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%		
Women	11	8,0	27	20,2	40	28,9	12	9,5	2	1,2	92	67,8
Men	2	1,7	10	7,3	28	20,1	4	3,1	-		44	32,2
Total	13	9,7	37	27,5	68	49	16	12,6	2	1,2	136	100

To assess the degree of hip dysplasia, the Crowe classification was used [9], according to which the proximal displacement of the femoral head by a distance of less than 10% of the pelvic height (less than 50% of the head height) corresponds to the I degree, at a distance of 10-15% of the pelvic height (50-75 % of the height of the

head) - II degree, at a distance of 15 - 20% of the height of the pelvis (75-100% of the height of the head) - III degree, at a distance of more than 20% of the height of the pelvis (more than 100% of the height of the head) - IV degree of dysplasia. (table 2).

Table 2.

Distribution of patients according to Crowe classification

Power	Number of patients											
	Main group n-70				Total		Control group n-66					
	Women		Men				Women		Men		Total	
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%
I Power	24	34,4	15	21,4	39	55,8	28	27,4	21	21,2	49	48,6
II Power	10	14,3	8	11,2	18	25,5	16	14.3	10	9,6	26	23,9
III Power	8	8.4	5	5.8	13	14.2	13	13.1	10	9.4	23	22.5
IV Power	3	3.1	1	1.4	4	4.5	3	3.3	2	1.7	5	5.0
Total	56	60.2	35	39.8	70	100	60	58.1	43	41.9	66	100

The main and control groups were also matched by gender, age, severity of joint damage and by the method of endoprosthetics. In the clinical observation group, in 126 (92.7%) patients during X-ray and CT examination and preoperative planning, we revealed - marginal sclerosis, flatness of the acetabulum roof (decrease in the vertical slope of the acetabulum and Weberg's angle), mushroom deformity of the femoral head with cystic foci and aseptic necrosis. In patients who use crutches for a long time, osteoporosis of the femur and muscle atrophy of the affected lower limb were observed against the background of degenerative-dystrophic changes. The dominant part of the patients was registered with an orthopedist since childhood, regularly received courses of conservative treatment, 2 patients had previously undergone surgical intervention (open reduction, Shantz support osteotomies, intertrochanteric osteotomies, formation of acetabular roofs). Subluxation or dislocation of the femoral head was observed in these patients due to the underdevelopment of the acetabulum. The concomitant adductor-flexion contracture and limitation of movements in the hip joint impeded their movement, the gait was "duck". Patients with unilateral lesions had an asymmetry in the length of the limbs from 1 to 5 cm. For joint replacement, endoprostheses Zimmer -36, Bioimplant - 24, DePuy - 54, Irene - 11 were used, hybrid constructs were used in 6 cases. The reasons leading to loosening of the acetabular component in the immediate postoperative period include: violation of the technique for installing the acetabular component; inadequate selection of the size of the implantable endoprosthesis (for example, a small size of the endoprosthesis cup and over-machining of the acetabular cutter); cicatricial changes and inadequate release [2]. In the clinical picture, one can observe the appearance of an early pain syndrome in the area of the operated joint and, as a result, lameness. The patient starts to use additional support means again. The most valuable for the diagnosis of instability of the acetabular component are radiography and computed tomography. These methods made it possible to quantify the response of various anatomical zones of the acetabulum to implantation of the endoprosthesis. It was clinically important to exclude the body's inflammatory response to the implant. Therefore, we studied all available clinical and biochemical analyzes. The blood levels of calcium, phosphorus, alkaline phosphatase, and parathyroid hormone were examined in patients at risk of developing early aseptic instability.

**Surgical technique:** The hip arthroplasty was performed in a lateral position, under general anesthesia in 4 cases, combined general and spinal anesthesia in 132 cases. In order to ensure minimal trauma to the already atrophied muscles of the hip joint, the Harding approach was considered optimal; during an open examination of the acetabulum, its depth, orientation relative to the sagittal plane of the body, and the condition of the roof and posterior wall were specified. In Crowe grade III hip dysplasia, they tried to position the endoprosthesis cup as appropriate as possible, since restoration of the center of rotation of the head, adequate to the physiological one, provides optimal conditions for the functioning of the entire lower limb girdle and the implant itself. In 4 cases the installed cup under 430 protruded with its 1/3 part beyond the limits of the depression. Observations have shown that in most of the patients with hip dysplasia, cervical antivision is excessively expressed; therefore, the

orientation of the femoral component of the endoprosthesis was performed along the frontal plane. In order to facilitate the lowering and reduction of the head, decompression and reduction of friction of the components, as well as to reduce the pressure between the implant and the bone, tenotomy of the tendon part of m. iliopsoas (No. FAP 20100081). To eliminate the adduction contracture, subcutaneous tenotomy of the adductor muscles of the thigh was performed. The manufacturer indicated that, without cement prosthetics, the rasp is 0.3 mm less than the leg of the femoral component, which ensures its good fixation. We also know that the stem, installed using the press-fit method, sits in the cancellous part of the bone, where its osseointegration takes place. Insufficient processing of the femoral canal can cause aseptic instability of the stem, and processing to the cortical layer can lead to a split of the femur, since an expansion of 0.3 mm is not acceptable for the cortical part, it will simply burst. And in this case, you have to rely on the experience of the surgeon, who will determine by ear that the leg will not go further. This leads to the fact that if, before the operation, we planned to put the leg at a certain level and decided which head we would put. Then, after the operation, we visually find that we slightly lengthened the limb (due to the fact that the leg did not sit down to the intended level). When determining the length of the head, you can navigate by diastasis, after repositioning the test heads. However, for example, in patients with dysplasia who have been brought down, in order to eliminate the shortening, there may be no diastasis, while in elderly patients, due to muscle flabbiness, this diastasis between the head and the liner is unacceptably large. All this leads to patient dissatisfaction with different limb lengths, and with regard to aseptic instability, we also know that different limb length disrupts gait biomechanics, which will subsequently negatively affect the stability of implants. For this purpose, in order to intraoperatively correct the errors of preoperative planning in relation to the selection of the head length, we proposed a device (patent FAP 20190128) for intraoperative determination of the center of rotation of the femoral head. This device consists of an A-rod, B-rod and a connecting rod, the rods intersect strictly perpendicular to each other (Pic. 1). Rod A is inserted into the technical opening located in the proximal part of the endoprosthesis stem, which serves to insert it into the femoral canal using a guide. In this position, the rod A is parallel to the stem of the endoprosthesis. The next step is to install rod B on rod



(Pic. 1).

A, where rod B lies perpendicular to rod A. Having installed one end of rod B on the apex of the greater trochanter, we determine the level of the center of rotation of the head on the neck of the endoprosthesis stem. It remains only to select the appropriate head, the center of which will coincide with the center of rotation on the device.

## Results and discussion

The results were assessed after 3, 6, 12 months. after surgery, then annually. During the examination, radiographs of the pelvis in frontal projection and the operated joint in Launstein's projection were performed (Pic. 1a, b). Functional results were assessed using the W.H. Harris system [11].



A



B

Radiographs of the hip joint of a patient with dysplastic coxarthrosis. a - before surgery, b - 4 years later, after total arthroplasty of the right hip joint with the Howmedica implant - cement fixation. X-ray assessment of the cement mantle was carried out according to the Barrack et al system, which includes 4 categories (A, B, C, D): category A - uniform and complete filling with X-ray contrast cement of the space of the medullary canal around

the stem of the endoprosthesis; category B - presence of minor defects at the cement-bone interface; category C - X-ray image enlightenment at the cement - bone border, 50 to 99% or incomplete mantle; category D - brightening up to 100% or no cement in the apex of the pedicle. We analyzed the dynamics of the X-ray density at the implant-bone interface, according to the Gruen system, in 7 zones around the stem of the endoprosthesis (Pic. 2).



Pic. 2.



Pic. 3.

Pic. 2. Assessment of the state of the femoral component according to the Gruen system.

Pic. 3. Assessment of the state of the acetabular component according to the De Lee and Charnley system. The status of the acetabular component was assessed by De Lee and Charnley. The average observation period for patients was  $21.4 \pm 11.7$  (from 3 to 72 months). The main variants of changes in bone tissue were identified, such as: resorption, hypertrophy and remodeling. Resorption

with a diffuse increase in bone transparency was observed in the proximal zones (1), and trabecular reorientation in zone 7. In 59 cases (84%) in the patients of the main group in the distal regions (zones 3,4,5), we noted hypertrophy in the form of an increase in the mass of the cortical layer. No changes were found in the middle sections (2,6 zones). In 63 (96%) patients of the control group, hypertrophy was observed in the form of entrainment of the cortical layer in the distal regions.

Functional assessment.

Tab. 3.

**The result of evaluating the effectiveness of hip arthroplasty. (W.H. Harris scale)**

Treatment results (in points)	Excellent (100-90)		Good (89-80)		Satisfactory (79-70)		Unsatisfactory Less than 69		Total	
	abs.	%	abs.	%	abs.	%	abs.	%	abs.	%%
Total group	25	35.7	40	56.3	4	6.4	1	1.6	70	100
Control group	22	33.5	34	52.3	7	11.5	2	2.7	66	100

Table 3 shows that in the main group excellent and good results were found in 65 patients (92%). In the control group, excellent results were recorded only in 22 patients (33.5%) due to an increase in the cohort with good outcomes. In this group, the proportion of satisfactory outcomes was 7 patients (11.5%). Out of 136 operated patients for dysplastic coxarthrosis, 18 (13.3%) patients underwent revision of the endoprosthesis area in terms of 3 to 15 years. Moreover, in 6 (4.12%) patients, re-endoprosthesis was performed twice. In 8 (6.18%) cases, the stem of the endoprosthesis was replaced (Irene endoprosthesis), in 7 (5.15%) cases, the endoprosthesis cup was replaced (Bioimplant endoprosthesis). In 7 (5.15%) cases, both components were replaced. When the cup of the endoprosthesis was protruded, reimplantation was performed with bone grafting of the bottom of the acetabulum with an autograft taken from the iliac crest. A lot of technical troubles arise when lowering the operated limb with III-IV degrees of hip dysplasia according to Growe. Forced reduction is fraught with the fact that this increases the pressure of the head of the endoprosthesis into the cavity, disrupting the spatial orientation of the components of the endoprosthesis, accelerates the aseptic instability of the components of the endoprosthesis, in addition, leads to tension in the anterior muscle group, causing a sharp limitation of flexion in the knee joint.

To eliminate or at least reduce such negative phenomena, it is necessary to perform tenotomy of the tendon m. iliopsoas and subcutaneous tenotomy of the adductor muscles of the thigh. At the same time, it becomes possible to eliminate the shortening of the diseased limb, reduce the compression pressure, prevent aseptic instability of the endoprosthesis components, and reduce the wear of rubbing surfaces. During hip arthroplasty in patients with dysplastic coxarthrosis, there are the following unfavorable conditions that adversely affect the strength of fixation of the implant components: defects of the femur and acetabulum; lack of walls of the acetabulum; bending of the medullary canal; narrowing of the proximal femur. The presence of the above anatomical variations causes limb shortening and mixing of the center of rotation of the joint. In this case, it is necessary to plan the installation of the acetabular component so that the center of rotation of the

endoprosthesis coincides with the center of rotation of the joint. As we can see, during hip arthroplasty in conditions of dysplasia, two problems arise: significant changes in the biomechanics of the hip joint and the discrepancy between the shape and size of conventional implants to the shape and size of the patient's acetabulum and femur. It should be noted that the success of total hip arthroplasty, especially in cases of dysplasia, depends on the stability of the acetabular and femoral components of the endoprosthesis with their correct anatomical ratios. The correct anatomical relationships can sometimes be achieved only by reconstructive osteoplastic interventions in the acetabulum and proximal end of the femur. Among them, the restoration of the level of rotation of the heads along the planes plays an important role. At the same time, not only the lowering of the hip and decompression of the joint is achieved, which lead to the elimination of the gap along the Shenton line and the restoration of the length of the limb, but also normalize the muscle balance, which enhances the abduction, extensor and internal-rotating effect of the gluteal muscles. Comparative analysis showed that immediate, mid-term and long-term results (excellent 35.7%, good 56.3%) after primary hip arthroplasty in patients of the main group with late stage coxarthrosis compared with the control group (excellent 33.5%, good 52.3%), average follow-up which was 5.1 years, testifies to the high efficiency of using the effectiveness of the developed method of tenotomy of the tendon m. iliopsoas

## Conclusions

1. For the purpose of decompressive mobilization of the hip joint, when bringing down the femur, it is necessary to perform a "notch" plasty m. iliopsoas and subcutaneous tenotomy of the adductor muscles of the thigh.
2. In the presence of defects in the acetabulum, reconstructive surgery is required before, or at the time of arthroplasty.
3. When placing the cup in a dysplastic cavity, it is necessary to achieve primary stability of the pelvic component of the endoprosthesis.
4. In hip arthroplasty, it is necessary to plan the installation of the endoprosthesis components so that the



center of rotation of the endoprosthesis coincides with the center of rotation of the joint.

#### LIST END LITERATURE:

1. Kavalerskiy G.M., Sereda A.P., Murylev V.Yu., Rukin Ya.A., Gavrilov A.V., Arkhipov I.V. et al. 2D planning of hip arthroplasty. *Traumatology and Orthopedics of Russia*. 2015; (4): 95-102. doi: 10.21823/2311-2905-2015-0-4-95-102.
2. Petrov A.B., Kovaleva I.D., Ruzanov V.I. Method of acetabuloplasty for hip dysplasia // *Modern technologies in traumatology, orthopedics: errors and complications, prevention and treatment / Materials, inter. Congress (October 5-7, 2004).* - M., 2004. - S. 127.
3. Ribachuk OI, Kukuruza LP, Torchinsky VP Total endoprosthetics of the stump with yagodysplasii // *Orthopedist., Traumatology.*, 1999.-№1. - P.29-30.
4. Sergeev KS, Katrenko IN, Toropov EV, Kuznetsov IV, Markov AA. Errors, complications and measures of their prevention in hip arthroplasty // *Modern technologies in traumatology, orthopedics: Errors and complications, prevention and treatment / Materials between. Congress (October 5-7, 2004).* -M., 2004. - S.151.
5. Tikhilov R.M., Shapavalov V.M. Guidelines for Hip Replacement Surgery. - SPB, 2008. - 293 - 301.
6. Lachiewicz P., McCaskill B., Inglis A. et al. Total hip arthroplasty in juvenile rheumatoid arthritis two to eleven -year result. // *J. Bone J Sur.* - 1986. - Vol. 68A. - P. 502-508.
7. Radl R., Hungerford M. et al. Higher failure rate and stem migration of an uncemented femoral component in patients with femoral head osteonecrosis than in patients with osteoarthritis. // *Act Orthop. Scand.* -2005. - Vol. 76,N 1. - P.49 - 55.
8. Zeng W.-N., Liu J.-L., Jia X.-L., Zhou Q., Yang L., Zhang Y. Midterm Results of Total Hip Arthroplasty in Patients With High Hip Dislocation After Suppurative Hip Arthritis. *J Arthroplasty*. 2019;34(1):102-107. doi: 10.1016/J.ARTH.2018.09.081.
9. Ling T.-X., Li J.-L., Zhou K., Xiao Q., Pei F.-X., Zhou Z.-K. The Use of Porous Tantalum Augments for the Reconstruction of Acetabular Defect in Primary Total Hip Arthroplasty. *J Arthroplasty*. 2018;33(2):453-459. doi: 10.1016/J.ARTH.2017.09.030.
10. Zha G.-C., Sun J.-Y., Guo K.-J., Zhao F.-C., Pang Y., Zheng X. Medial Protrusio Technique in Cementless Total Hip arthroplasty for Developmental Dysplasia of the Hip: A Prospective 6- to 9-Year Follow-Up of 43 Consecutive Patients. *J Arthroplasty*. 2016;31(8):1761-1766. doi: 10.1016/J.ARTH.2016.01.052.
11. Eskildsen S.M., Wilson Z.J., McNabb D.C., Olcott C.W., Del Gaizo D.J. Acetabular Reconstruction With the Medial Protrusio Technique for Complex Primary and Revision Total Hip Arthroplasties. *J Arthroplasty*. 2017; 32(11):3474-3479. doi: 10.1016/J.ARTH.2017.05.037.
12. Greber E.M., Pelt C.E., Gililland J.M., Anderson M.B., Erickson J.A., Peters C.L. Challenges in Total Hip Arthroplasty in the Setting of Developmental Dysplasia of the Hip. *J Arthroplasty*. 2017;32(9):S38-S44. doi: 10.1016/J.ARTH.2017.02.024.
13. Montalti M., Castagnini F., Giardina F., Tassinari E., Biondi F., Toni A. Cementless Total Hip Arthroplasty in Crowe III and IV Dysplasia: High Hip Center and Modular Necks. *J Arthroplasty*. 2018; 33(6):1813-1819. doi: 10.1016/J.ARTH.2018.01.041.
14. Galea V.P., Laaksonen I., Donahue G.S., Fukui K., Kaneuji A., Malchau H., Bragdon C. Developmental Dysplasia Treated With Cementless Total Hip Arthroplasty Utilizing High Hip Center Reconstruction: A Minimum 13-Year. Follow-up Study. *J Arthroplasty*. 2018;33(9):2899-2905. doi: 10.1016/j.arth.2018.04.037.
15. Berninger M.T., Hungerer S., Friederichs J., Stuby F.M., Fulghum C., Schipp R. Primary Total Hip Arthroplasty in Severe Dysplastic Hip Osteoarthritis With a Far Proximal Cup Position. *J Arthroplasty*. 2019;34(5):920-925. doi: 10.1016/J.ARTH.2019.01.032.
16. Komiyama K., Nakashima Y., Hirata M., Hara D., Kohno Y., Iwamoto Y. Does High Hip Center Decrease Range of Motion in Total Hip Arthroplasty? A Computer Simulation Study. *J Arthroplasty*. 2016;31(10): 2342-2347. doi: 10.1016/J.ARTH.2016.03.014.
17. Rowan F.E., Benjamin B., Pietrak J.R., Haddad F.S. Prevention of Dislocation After Total Hip Arthroplasty. *J Arthroplasty*. 2018;33(5):1316-1324. doi: 10.1016/J.ARTH.2018.01.047.
18. Karaismailoglu B., Erdogan F., Kaynak G. High Hip Center Reduces the Dynamic Hip Range of Motion and Increases the Hip Load: A Gait Analysis Study in Hip Arthroplasty Patients With Unilateral Developmental Dysplasia. *J Arthroplasty*. 2019;34(6):1267-1272. doi: 10.1016/J.ARTH.2019.02.017.
19. Widmer D., Reising K., Kotter E., Helwig P. Correct Assessment of Acetabular Component Orientation in Total Hip Arthroplasty From Plane Radiographs. *J Arthroplasty*. 2018;33(8):2652-2659. doi: 10.1016/J.ARTH.2018.02.023.

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