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Results of Arthroscopic Treatment for Femoroacetabular Impingement

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Background. Femoroacetabular impingement (FAI) is one of the most frequent causes of hip pain and limited hip mobility in young and middle-aged patients. It is a result of repeated injury of hip structures, that leads to degenerative changes in hip labrum, cartilage and subchondral bone and provokes progressive development of hip osteoarthritis.

Aim of study — to analyze own experience of treating patients with femoroacetabular impingement and identify factors affecting its outcomes.

Methods. Retrospective, uncontrolled, single-center clinical study included 128 patients with FAI which had 150 surgeries on 149 joints in in the period from 2013 to 2021. All patients underwent physical examination and X-ray diagnostics, their FAI type was identified. The alpha angle of external part of femoral head in anterior-posterior position and in the modified Dunn 45° position, as well as Tonnis angle, lateral central-marginal angle in Ogata modification and the height of articular gap along the lateral (LS) and medial edges (MS) of sclerosed acetabulum part were calculated. The i-HOT-33 and HOS scales were used to assess preoperative status and postoperative results.

Results. The average follow-up period was 3.9 years (SD 1.71; min 1.05 and max 8.16). The study included 55 (43.0%) women and 73 (57.0%) men which underwent 64 (42.7%) and 86 (57.3%) surgeries respectively. The most common types of FAI, according to our data, were mixed type (53% of joints) and cam type (27.5% of joints). Insufficient coverage of the femoral head by the acetabulum (borderline dysplasia) in combination with the cam deformity of the femoral head was observed in 18.1%. Pincer-type FAI was observed in 1.4% of joints. We obtained the worst results with a combination of cam deformity and borderline dysplasia in comparison with cam- and mix-type FAI according to the i-HOT-33 and HOS scales. Patients' age, deep cartilage damage, irreparable labrum damage and height decrease of the lateral part of the articular gap determined negative effect on treatment results according to the i-HOT-33 and HOS scales.

Conclusion. Hip arthroscopy showed good short- and midterm outcomes in patients with FAI. Pain syndrome is most often manifested in patients with pathology of hip soft tissue structures concomitant to FAI. The combination of cam deformity and insufficient femoral head coverage, deep cartilage damage and a height decrease of the articular gap are important predictors of poor treatment results.

Keywords: arthroscopy, femoroacetabular impingement, pincer deformity, cam deformity, hip dysplasia, retroversion.

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Результаты артроскопического лечения фемороацетабулярного импинджмента

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Актуальность. Фемороацетабулярный импинджмент (ФАИ) является одной из наиболее частых причин болевого синдрома и ограничения подвижности в тазобедренном суставе (ТБС) у лиц молодого и среднего возраста в результате повторяющейся травматизации структур сустава, приводящих к дегенеративным изменениям суставной губы, хряща, субхондральной кости и ведущих к прогрессирующему развитию остеоартроза ТБС.

Цель исследования — на основании анализа собственного опыта лечения пациентов с ФАИ выявить факторы, оказывающие влияние на его результат.

Материал и методы. Выполнено ретроспективное неконтролируемое одноцентровое клиническое исследование. В него вошли 128 пациентов (149 суставов) с ФАИ, которым было выполнено 150 операций в период с 2013 по 2021 г. Из них было 55 (43,0%) женщин и 73 (57,0%) мужчины. Средний период наблюдения составил 3,9 лет (SD 1,71; min 1,05; max 8,16). Всем пациентам проведено физикальное обследование и лучевая диагностика с определением типа ФАИ, выполнен расчет угла α головки бедренной кости в прямой проекции и модифицированой укладке Dunn 45°, угла Tönnis, латерального центрально-краевого угла в модификации Ogata, высоты суставной щели по латеральному (LS) и медиальному краям (MS) склерозированной части вертлужой впадины. Для оценки предоперационного статуса и послеоперационных результатов использованы шкалы i-HOT-33 и HOS.

Результаты. Наиболее часто встречались смешанный тип (53% суставов) ФАИ и cam-тип (27,5%) ФАИ. Недостаточное покрытие вертлужной впадины головки бедренной кости (пограничная дисплазия) в сочетании с cam-деформацией головки бедренной кости выявлено в 18,1% суставов. Pincer-тип ФАИ определен в 1,4% суставов. При сравнении результатов лечения по шкалам i-HOT-33 и HOS нами получены наихудшие результаты при сочетании cam-деформации и пограничной дисплазии в сравнении с cam-типом и mix-типом ФАИ. Также выявлено отрицательное влияние на исход лечения более старшего возраста пациента, глубокого повреждения хряща, невосполнимых повреждений суставной губы и снижения высоты латерального отдела суставной щели.

Заключение. Артроскопия тазобедренного сустава показывает хорошие кратко- и среднесрочные результаты при лечении пациентов с ФАИ. Болевой синдром чаще всего проявляется при сопутствующей ФАИ патологии мягкотканных структур тазобедренного сустава. Сочетание cam-деформации и недостаточного покрытия головки бедренной кости вертлужной впадиной, глубокие повреждения хряща, невосполнимые повреждения суставной губы и снижение высоты суставной щели являются важными предикторами неудовлетворительных исходов лечения.

Ключевые слова: артроскопия, фемороацетабулярный импинджмент, pincer-деформация, cam-деформация, дисплазия, ретроверсия.

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BACKGROUND

Femoroacetabular impingement (FAI) is a pathologic process characterized by chronic mechanical damage of articular labrum, cartilage and acetabular rim by femoral head or neck because of their abnormal morphology, accompanied by the pain syndrome and quite often by the limited range of motions in the hip joint [1, 2, 3]. FAI is one of the most frequent causes of joint pain and limited hip mobility in young and middle-aged patients, but still there are no reliable epidemiological data. Repeated injuries of hip joint structures lead to degenerative changes in labrum, cartilage and subchondral bone that provokes progression of hip osteoarthritis [4, 5, 6].

The most popular FAI classification includes three main FAI types: cam-type, pincer-type and mix-type.

Cam-type supposes femoral head and neck deformity with normal acetabulum. Head deformity is most often located in its anterosuperior and external parts, however, dysmorphology of its spherical shape may be located in other parts as well [7].

Pincer-type is characterized by acetabular dysmorphology and can be represented by local or total deformity. Total deformity includes deep acetabulum and acetabular protrusion. Local deformity implies acetabulum retroversion or prominent anterior margin of acetabulum [1].

Mix-type is a combination of cam- and pincer-types.

Different FAI types have various impacts on development of secondary osteoarthritis of the hip joint. It is considered that the cam-type is the most significant osteoarthritis predictor, and its negative effect increases with the α angle increase [3].

FAI surgical treatment is focused on restoration of congruence of articular surfaces and elimination of pathologic changes in articular labrum and cartilage [3, 8]. Arthroscopy is a modern method of FAI surgical treatment.

Aim of study – to analyze our experience of treating patients with femoroacetabular impingement and to identify the factors affecting its outcomes.

METHODS

Study design

Study design: clinical retrospective uncontrolled single-center study.

The study includes patients who underwent hip arthroscopy from June 2013 to January 2021 concerning clinically and radiologically confirmed FAI.

Exclusion criteria:

– prior hip surgeries;

– femoral head chondromatosis and osteonecrosis;

– prior Legg-Calve-Perthes disease;

– impossibility to evaluate results within 12 months minimum.

Exclusion and inclusion criteria been applied, the study enrolled 128 patients (149 joints) who underwent 150 surgeries. One patient (woman) had revision arthroscopy 5.6 months after the primary surgery due to an incorrect choice of cam-deformity resection area. Among 128 patients were 55 (43%) women and 73 (57%) men. Average follow-up period was 3.9 years (SD 1.71; min 1.05; max 8.16), minimum period was 1 year.

Examination of patients

All patients were physically examined, their range of motions in the hip joint was evaluated using diagnostic tests, such as flexion-adduction - internal rotation (FADIR) test, flexion-abduction - external rotation (FABER) test and Thomas test. Age, sex and duration of symptoms' manifestation were also taken into account in our study.

Plain pelvis X-ray in the upright position as well as in the modified Dunn 45° position with external 40° rotation of the femur were performed to all patients before the surgery. Using X-rays, we identified their FAI types and calculated the α angle of external and anterosuperior parts of the femoral head, as well as the Tönnis angle, the lateral central-marginal angle in Ogata modification (LCEA-0) and the height of articular gap along the lateral (LS) and medial edges (MS) of sclerosed part of acetabulum. Methods of calculation based on X-rays are specified in details in our previous publication [9]. All patients had hip MRI before the surgery.

Operative technique

Hip arthroscopy was performed by one surgeon via standard approaches. Surgery tactics and extent depended on morphologic changes in the joint.

The first stage consisted of arthroscopic correction of intraarticular damages without joint distraction. Modelling resection of femoral head and neck deformity was performed. The state of articular labrum, acetabulum and femoral neck cartilage was evaluated after joint distraction. In case of full-thickness labrum damage the latter was sutured with the use of anchors (Fig. 1).

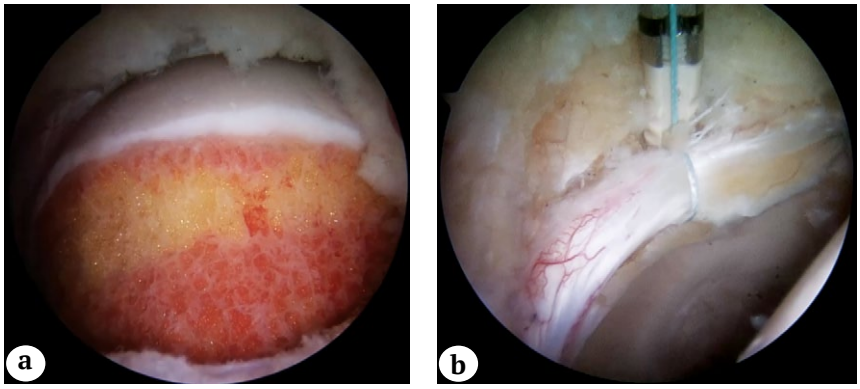

Fig. 1. The main stages of correction of intraarticular damages:
a — modeling resection of cam-deformity;
b — articular labrum refixation

In case of superficial damages of articulating surface, the affected parts of the labrum were resected by shaver preserving its integrity. Full-thickness ossification of specific labrum segments was removed within normal tissues without defect restoration. Identified unstable parts of the cartilage were resected. In some cases, full-thickness cartilage defects of the acetabulum were replaced by the chondral matrix implanted into the cartilage defect area with no additional fixation after the subchondral bone debridement and microfracturing.

Localization of femoral head and neck deformity as well as damage type and extent of articular labrum and cartilage were evaluated during the surgery. Cartilage damage of femoral head was assessed according to the Outerbridge classification, that of acetabulum – according to the Beck et al. classification [11].

Postoperative follow-up

Patients were activated during the first 24 hours after the surgery. In the postoperative follow-up period, they were recommended to use crutches with 15% body weight bearing on the operated leg for 3 weeks (5 weeks in patients with damaged acetabulum cartilage replaced by chondral matrix) and to start full weight bearing in 2 more weeks.

Assessment of results

To evaluate the preoperative status, we used the International Hip Outcome Tool-33 (i-HOT-33) and the Hip Outcome Score (HOS) scales completed by patients before the surgery. In the postoperative period all patients continued to complete the questionnaires remotely in Google forms every year, starting with the first one after the surgery. Data obtained during the last survey were used for our analysis. Results vary from 0 to 100 with the highest scores being the best.

Statistical analysis

Analysis of correspondence of frequency data distribution in each of compared groups to normal distribution was performed before comparing variables. No statistically significant difference between variances of compared groups was identified (homogeneity of variances), that made it possible to compare variables using Student's t-test. T-test for independent variables was used to compare variables of both groups, while t-test for dependent variables was used to compare scores before and after the surgery. Pearson's correlation coefficient (Pearson's r) was applied to describe the correlation between radiologic angles and range of motions. Values of variables were presented as mean value, standard deviation (SD), minimum value (min) and maximum value (max). Statistical significance level (p-level) in our study was set as 0.05. Data base was presented in Excel tables, statistical analysis was performed in Statistica 12 software (StatSoft) X86 for Windows.

RESULTS

Age, body mass index (BMI), duration of symptoms' manifestation before surgery, performed X-ray measurements and results of i-HOT-33 and HOS questionnaires are shown in the Table 1.

Correlation between hip flexion angle, internal rotation of femur with 90° hip flexion and sphericity angles of femoral head in anteroposterior view and in the modified Dunn 45° setup is identified (Tab. 2). No statistically significant difference between other variables was discovered. Table data show that in general there is an inverse correlation between the α angle and the range of motions in the hip joint.

Examining 149 X-rays of the hip joint and evaluating deformity of femoral head/neck and acetabulum, we separated out 4 types of deformities (Tab. 3).

Table 1

Preoperative characteristics of patients, M±SD

Parameter	Women (63 joints)	Men (86 joints)	p
Age, y.o.	34.83±10.64	32.48±8.68	0.11
BMI, kg/m^2	22.11±3.58	24.63±2.44	<0.01
Duration of symptoms' manifestation, month	29.56±29.47	39.49±34.86	0.09
LCEA-O, deg.	26.57±6.75	28.31±5.66	0.09
Tönnis angle, deg.	5.03±6.16	4.26±5.36	0.42
A-p α angle, deg.	51.50±19.32	66.40±19.69	<0.01
Dunn α angle, deg.	60.02±15.47	65.12±14.95	0.04
Flexion, deg.	118.52±15.42	113.20±16.25	0.045
Internal rotation with 90° hip flexion	21.95±11.01	13.90±10.83	<0.01
External rotation, deg.	38.20±7.09	37.73±7.54	0.70
Height of articular gap along the lateral part of acetabulum, mm	4.59±0.86	4.86±0.93	0.07
Height of articular gap along the medial part of acetabulum, mm	4.20±0.97	4.37±0.86	0.29
i-HOT-symptoms	57.90±21.82	61.34±20.64	0.33
i-HOT-sport	40.91±22.32	43.28±25.47	0.55
i-HOT-work	40.00±20.70	41.28±22.17	0.72
i-HOT-emotions	44.52±21.60	50.97±22.83	0.08
HOS-ADL	71.37±19.60	74.31±17.95	0.34
HOS-sport	48.09±28.43	55.04±24.91	0.11

Table 2

Correlation between flexion angle, internal rotation of the femur and α angle values in the group in general and in accordance with the patients' sex

View	α angle					
	A-p	Dunn 45°	A-p (W)	Dunn 45° (W)	A-p (M)	Dunn 45° (M)
FL	-0.2449 p = 0.003	-0.2107 p = 0.010	-0.2580 p = 0.040	-0.1511 p = 0.233	-0.1639 p = 0.131	-0.2164 p = 0.045
IR90	-0.2398 p = 0.003	-0.2712 p = 0.001	-0.2795 p = 0.025	-0.1922 p = 0.128	-0.0256 p = 0.815	-0.2620 p = 0.015

FL — flexion angle in the hip joint; IR90 —90° flexion in the hip joint; a-p — pelvis X-rays in the anteroposterior view; Dunn 45° — X-rays in the modified Dunn 45° position; M — men; W — women.

Table 3

Types of hip deformities

Deformity	Number of joints		
	Total (n = 149)	Women (n = 63)	Men (n = 86)
Cam	41 (27.5%)	20 (31.7%)	21 (24.4%)
Pincer	2 (1.4%)	2 (3.2%)	0
Cam + pincer (mix)	79 (53%)	27 (42.9%)	52 (60.5%)
Cam + borderline dysplasia	27 (18.1%)	14 (22.2%)	13 (15.1%)

Mean surgery duration was 177.83 minutes (SD 40.63; min 110, max 295) in women and 193.6 minutes (SD 45.88; min 105, max 310; p = 0,03) in men.

Characteristics of identified acetabular labrum damages, performed procedures as well as cartilage lesions are shown in the Table 4. Most often, articular labrum damage and acetabular cartilage lesion were localized in anterosuperior region (Fig. 2).

In 20.8% (5 surgeries) of 24 surgeries, where flap damage and acetabular cartilage desquamation (Beck grade 4 and 5) were revealed, the affected cartilage was replaced with chondral matrix. In this cohort of patients, the resection of unstable parts of the cartilage and the curettage of subchondral bone in the area of the cartilage defect were performed in 10 (41.7%) surgeries, while the resection of unstable cartilage parts and microfracturing were carried out in 8 (33.3%) surgeries. In one (4.2%) case the patient with cartilage lesion and acetabular cyst underwent cyst grafting with allogenous bone and defect covering with chondral matrix. In other patients with surface cartilage damage and insignificant marginal deep lesions, smoothing of damaged areas using shaver and arthroscopic electrocoagulator was performed.

Table 4

Intraoperatively identified damages of acetabular labrum, acetabulum cartilage and femoral head

Parameter	Number of joints (%)
Damage of acetabular labrum	136 (91.3)
– fixation of damaged parts of acetabular labrum	108 (72.5)
– resection of damaged parts of acetabular labrum	16 (10.7)
– resection of surface damages of acetabular labrum	12 (8.1)
Damage of acetabulum cartilage	97 (65.1)
– surface damage (Beck grade 1)	31 (20.8)
– deep cartilage damage (Beck grades 2 and 3)	42 (28.2)
– flap damage and cartilage desquamation (Beck grades 4 and 5)	24 (16.1)
Damage of femoral head cartilage	31 (20.8)
– surface damage (Outerbridge grades 1 and 2)	22 (14.8)
– deep damage (Outerbridge grades 4 and 5)	9 (6.0)

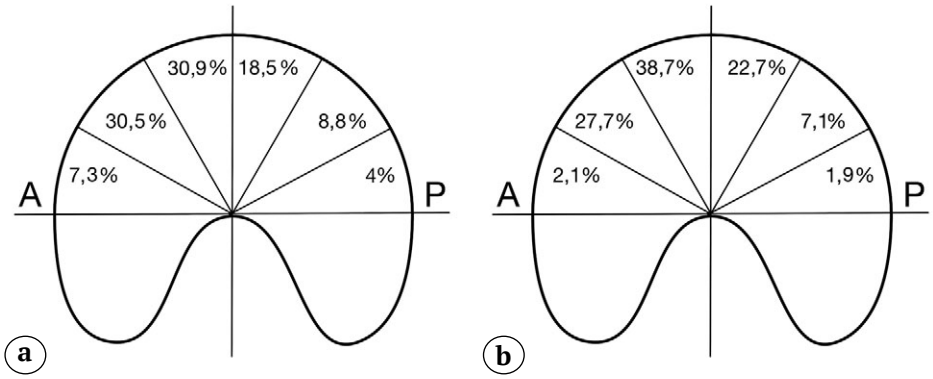

Fig. 2. Localization and damage frequency of labrum (a) and articular cartilage (b)

Damages of femoral head cartilage were identified in 31 (20.8%) patients (Fig. 3). These patients underwent resection of unstable fragments, smoothing of affected areas using shaver and arthroscopic electrocoagulator.

M. psoas tenotomy concerning psoas-impingement was performed during 20 (13.4%) surgeries in 17 (13.3%) patients. Through 2013 to 2016 the capsule was not sutured in 17 (11.3%) surgeries.

No cases of postoperative infection were noted. Partial impairment of sensation of external cutaneous nerve was observed in 20 (13.4%) cases. It resolved spontaneously in 17 (85%) cases in 17 weeks (SD 26.23; min 1; max 104), and did not show signs of recovery in 3 (15%) cases. Eleven (7.3%) patients complained about impaired sensation in genital area, that resolved spontaneously in 4.18 weeks (SD 2.09; min 1; max 8). Heterotopic ossification of deep layers of capsule (Brooker grade 1 [12]) was discovered in 3 patients (2% of operated joints). However, these findings cannot be considered accurate as the majority of patients have not presented control pelvis X-ray 1 year after the surgery.

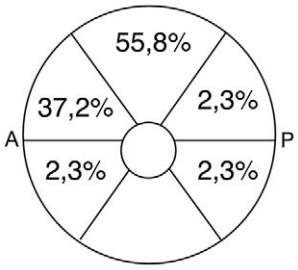

Fig. 3. Localization and frequency of femoral head cartilage damage

Eight patients (8 (5.3%) joints) underwent hip arthroplasty in average in 40.2 months (SD 25.3; min 8.4; max 74.4).

Comparison of patients' responses in the i-Hot-33 and HOS questionnaires, who did not need arthroplasty, before surgery and at the time of our study shows improvement of the hip joint state after surgical treatment (Tab. 5). No statistically significant differences between treatment results of men and women were discovered.

Table 5

Evaluation of patients' state according to the i-HOT 33 and HOS scales who underwent hip arthroscopy concerning FAI and did not need arthroplasty (n = 120), M±SD

Scale	Before surgery	After surgery
HOS-sport	53.70±26.06	80.95±22.19
HOS-ADL	73.58±18.90	92.27±12.46
i-HOT-emotions	49.15±22.53	83.77±20.60
i-HOT-work	41.73±21.63	65.67±19.48
i-HOT-sport	43.18±24.46	78.23±23.72
i-HOT-symptoms	60.84±21.07	86.67±18.66

Treatment outcomes varied depending on the FAI type (Tab. 6). The best result was achieved in the cam-type patient group, the worst – in the group with the cam-type combined with borderline dysplasia. Treatment results of 2 patients with pincer-type were not included in the comparison.

Three subgroups were formed in order to discover other factors affecting treatment results. Two subgroups included 120 (94%) patients (141 (94.6%) joints), who did not need hip arthroplasty. Patients included in the first or in the fourth quartiles, excluding the interquartile range, were identified basing on each section of questionnaire, under condition of confirmation of the worst (first quartile) and the best (fourth quartile) outcome according to 4 out of 6 sections of questionnaires.

Subgroup of patients with the best outcomes, that was notionally named as control subgroup in our study, was formed according to the results of this division and included 35 (26.3%) patients (41 (29.1%) joints). The second subgroup, the main one, included 25 (19.5%) patients (27 (19.2%) joints) with the worst outcomes, who did not need arthroplasty during the follow-up period. Eight (6.3%) patients (8 (5.3%) joints), who required arthroplasty, compiled the third subgroup.

No statistically significant differences between subgroups were identified in terms of duration of symptoms' manifestation, BMI, the α angle, the LCEA-O, the Tönnis angle, MS (Tab. 7).

Data presented in the Table 7 attest range of motions and articular gap height decrease from control to main and further on to arthroplasty groups. Reverse tendency was observed when evaluating the subgroups' mean age.

Due to a small number of patients, who underwent arthroplasty, no gender comparison was made.

Gross appearance of intraarticular deformities and intraoperatively identified damages of articular components in all subgroups is presented in the Table 8.

Control group was characterized by predominance of repairable articular labrum damages and less severe cartilage lesions than the main one. In the arthroplasty group the frequency of deep cartilage damages and irreparable articular labrum lesions was the highest in comparison with other groups. Assessing the deformities, the prevalence of cam-deformity in the control group and cam-deformity combined with borderline dysplasia in the arthroplasty group stands out.

Table 6

Comparison of treatment results of patients in accordance with different FAI types (147 joints), M±SD

Scale	FAI type			*p* value of comparison of groups *		
	cam (n = 41)	mix (n = 79)	cam + borderline dysplasia (n = 27)	1	2	3
HOS-sport	81.64±25.08	77.67±27.02	69.55±32.01	0.44	0.09	0.20
HOS-ADL	91.32±17.28	88.57±22.53	83.17±27.99	0.50	0.14	0.32
i-HOT-emotions	85.21±23.74	79.83±26.14	74.33±29.45	0.27	0.10	0.36
i-HOT-work	70.51±18.50	61.67±23.53	56.98±25.18	0.04	0.01	0.38
i-HOT-sport	79.59±26.49	75.15±27.36	66.67±31.99	0.40	0.07	0.19
i-HOT-symptoms	84.68±24.09	83.85±24.45	78.59±28.35	0.86	0.35	0.36

* 1 — cam-type and mix-type; 2 — cam-type and cam-type with borderline deformity; 3 — mix-type and cam-type with borderline deformity.

Table 7

Distinguishing criteria in control subgroups, M±SD (min; max)

Criterion	Subgroup of patients			*p* value of comparison of subgroups*		
	Control subgroup (41 joints)	Main subgroup (27 joints)	Arthroplasty subgroup (8 joints)	1	2	3
Age, y.o.	32.2±7.2 (19; 52)	33.07±9.41 (19; 54)	48.00±8.62 (34; 57)	0.66	<0.01	<0.01
Flexion, deg.	115.85±15.96 (80; 140)	114.44±14.50 (90; 140)	96.25±13.02 (80; 120)	0.71	<0.01	<0.01
Internal rotation with 90° hip flexion	17.56±11.41 (0; 35)	14.81±13.26 (0; 35)	7.50±9.26 (0; 25)	0.51	<0.01	0.19
External rotation, deg.	39.39±5.72 (25; 45)	35.37±9.70 (5; 45)	31.87±7.04 (20; 45)	0.04	<0.01	0.07
Height of articular gap along the lateral part of acetabulum, mm	5.12±0.91 (2.9; 6.5)	4.15±0.73 (2.8; 6.2)	3.55±0.69 (2.4; 5.3)	<0.01	<0.01	0.046

* 1 — between control and main subgroups; 2 — between control and arthroplasty subgroups; 3 — between main and arthroplasty subgroups.

Table 8

Quantitative characteristics of intraarticular deformities, damages and performed procedures in subgroups, *n* (%)

Parameter	Control subgroup (41 joints)	Main subgroup (27 joints)	Arthroplasty subgroup (8 joints)
Damage of acetabular labrum	38 (92.7)	27 (100)	8 (100)
– fixation of damaged parts	33 (80.5)	19 (70.4)	2 (25)
– resection of damaged parts	1 (2.4)	6 (22.2)	5 (62.5)
– resection of surface damages	4 (9.8)	2 (7.4)	1 (12.5)
Damage of acetabulum cartilage (according to Beck)	23 (56.1)	20 (74.1)	8 (100)
– surface damage (grade 1)	7 (17.1)	8 (29.6)	2 (25)
– deep damage (grades 2 and 3)	12 (29.3)	8 (29.6)	0
– flap damage and cartilage desquamation (grades 4 and 5)	4 (9.8)	4 (14.8)	6 (75)
Damage of femoral head cartilage (according to Outerbridge)	6 (14.6)	6 (22.2)	7 (87.5)
– surface damage (grades 1 and 2)	5 (12.2)	2 (7.4)	4 (50)
– deep damage (grades 3 and 4)	1 (2.4)	4 (14.8)	3 (37.5)
Types of deformities	41 (100.0)	27 (100.0)	8 (100.0)
– cam	17 (41.5)	7 (25.9)	1 (12.5)
– pincer	0	1 (3.7)	0
– cam + pincer (mix)	18 (43.9)	13 (48.1)	3 (50.0)
– cam + borderline dysplasia	6 (14.7)	6 (22.2)	3 (37.5)

DISCUSSION

Hip arthroscopy, performed in our study, improved the state of patients, increasing average scores according to both scales and their sections from 16.69 points in the HOS-ADL section to 35.05 points in the i-HOT-sport section. Insignificant relative HOS-ADL improvement is more likely connected with initially high preoperative mean score in this section, as it refers to young and active patients. Increase of chances to return to sport activities in this cohort of patients also revealed in the sport section of the HOS scale, where the mean score increased to 27.25 points that corresponds to A.A. Minkara et al. [13].

Multiple literature data report on the absence of significant influence of borderline dysplasia on short-term and mid-term results of the FAI surgical treatment [14, 15]. Analysis of patients' treatment results in control and main subgroups, notionally allocated in our study, also revealed no LCEA-O influence. However, it is worth mentioning relative prevalence of patients with cam-deformity in combination with borderline dysplasia (37.5%) in the subgroup of patients who needed arthroplasty during the follow-up period in comparison with control (14.7%) and main (22.2%) subgroups.

Obtained results reveal the worst prognosis of surgical treatment outcome of patients with cam-deformity combined with borderline dysplasia, that in future may lead to faster osteoarthritis progression rather than separate presence of these changes [16].

Long-term studies show increase of frequency of radiologically confirmed hip osteoarthritis in women by 13%, of arthroplasty – by 18% with the LCEA decrease by each degree with the values less than 28° in 20 follow-up years. According to the same study, the cam-deformity, in its turn, leads to 5% increase of radiologically diagnosed osteoarthritis and to 4% increase of frequency of hip arthroplasty with the α angle increased by 1° [8].

These data attest more favorable clinical course of cam-deformity rather than borderline dysplasia, that is confirmed by C.C. Wyles et al. [16]. However, according to the studies of R. Agricola et al., based on clinical course examination of primary osteoarthritis in 856 patients with cam-deformity and aged 45-65 years, the α angle of more than 60° and 80° increases 3.67-fold and 9.66-fold respectively the relative risk of hip arthroplasty [17].

Analyzing the systematic review of 13 studies that evaluate treatment results of 1571 joints with the follow-up period from 60 to 240 months, C. Kyin et al. also identified that the patients' age increase was one of the most significant predictors of ineffective FAI surgical treatment [18]. That fact is confirmed in our study as well. Mean age of patients in the arthroplasty group was 48.00 years old, in the control and the main ones was 32.20 and 33.07 years old respectively.

High frequency of asymptomatic hip joint deformities shows that the leading role in symptoms' manifestation belongs to articular labrum and cartilage damages and not to bone deformities [19, 20]. That fact is attested by C. Suarez-Ahedo et al., who revealed deep cartilage damages in 32.5% and articular labrum damages in 98% of 1502 patients enrolled in the study [21]. G. Bayley et al., examining 86 joints in 76 patients, identified articular labrum damage in 100% of cases with 42% of them without bone deformities [22], that also affirms pain syndrome progression due to the damage of intraarticular components.

It can be assumed that the more severe the damage to articular labrum and cartilage is, the worse the treatment result is. This conclusion is confirmed by the presence of articular labrum damage in 92.7% of patients in the control group and in 100% of patients in other groups. Moreover, the degree of its damage increases and the correcting potential of changes lessens from the control group to the main and the arthroplasty ones: 2.4%, 22.2% и 62.5% of articular labrum resections respectively. Frequency and severity of acetabular cartilage damage, that was identified in 56% of cases in the control group, in 74.1% in the main group, reaching 100% in the arthroplasty group, attest declination of results with increase of damage extent.

In 2013 M. Philippon et al. studied treatment outcomes of 203 patients aged more than 50 years old and made the conclusion that the articular gap height less than 2 mm was associated with the arthroplasty risk in 80% of cases [23]. Correlation between the arthroplasty risk and the articular gap height and age of patients was also confirmed in other researches [14, 17, 24, 25].

During the course of our study as well, we observed the height decrease of lateral part of ar-

ticular gap to 4.15 mm in the main subgroup and to 3.55 mm in the arthroplasty subgroup comparing with the control subgroup (5.12 mm). All that attend less hip arthroscopy efficacy in patients with smaller articular gap.

CONCLUSION

One of the most unfavorable combinations affecting treatment results is the combination of cam-deformity and insufficient coverage of the femoral head by the acetabulum.

Taking into account the identified concomitant articular labrum and cartilage pathologies in most patients, we may assume that these concomitant soft tissue lesions lead to pain syndrome in case of FAI. Defects of acetabulum and femoral head cartilage, as well as articular gap decrease are considered prognostically unfavorable for hip arthroscopy results increasing its negative effect especially in elderly patients. According to that, we can suppose that early correction of deformities not only allows to reduce the pain syndrome, but also prevents further damages of acetabulum cartilage and articular labrum, that will enable to obtain better long-term results and, perhaps, decrease the necessity and delay hip arthroplasty.

DISCLAIMERS

Author contribution

Bogopolskiy O.E. — collection and processing of material, analysis and statistical processing of data, manuscript writing.

Trachuk P.A. — collection and processing of data.

Spetsialnyi D.V. — collection and processing of data.

Sereda A.P. — analysis and statistical processing of data, data statistical processing, text editing.

Tikhilov R.M. — study conception and design, text editing.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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