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Long-Term Results of Total Hip Arthroplasty with RM Classic Cups

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Abstract

Relevance. The RM Classic monoblock titanium-coated polyethylene cup is widely used in the total hip arthroplasty. However, so far in Russia there has been no analysis of follow-up over 10 years for a limited number of patients in a single hospital. ***The aim of the study*** was to evaluate the long-term outcomes of total hip replacement with RM Classic acetabular component. ***Materials and Methods.*** The outcomes of 328 total hip arthroplasties (289 patients operated in the period from 1997 to 2007) with RM Classic cups were evaluated in a monocentral retrospective clinical study. The average follow-up period was 14.4 years. Revision procedure due to aseptic loosening, polyethylene wear or osteolysis was considered as the end point of the study. ***Results.*** 9 revisions during the short and medium follow-up periods (up to 10 years) were associated with malpositioning of RM Classic components and errors in surgical technique. The indications for later revision THA (19 cases) were polyethylene wear and aseptic loosening. Only in one case they were combined with pelvic bone osteolysis with the formation of III a defect according to W.G. Paprosky classification. Within 15 years the Kaplan-Meier survivorship of RM Classic cup was 92.5%. There was a statistically significant difference of the survival curves in the ceramic-on-poly against metal-on-poly bearings: 94.9% and 79.4%, respectively. The average Harris Hip Score was 88.6. ***Conclusion.*** RM Classic uncemented monoblock cup has proven its high efficiency and survival in 15 years follow-up period and over.

Keywords: total hip arthroplasty, uncemented monoblock titanium-coated polyethylene cup, acetabular components survivorship.

Relevance

Robert Mathys Senior, engineer and honorary doctor of medicine in the framework of elaborating the isoelastic concept of arthroplasty developed in 1985 the RM Classic monoblock polyethylene cup covered by pure titanium particles [1]. The elasticity module of this cup corresponded to the elasticity of the pelvic bone. To ensure resonance of their deformities the implant was rigidly fixed in the bone bed of exact cup size by two anchoring pegs and peripheral diverging screws [2].

Historically RM Classic was the most commonly used acetabular component of imported hip joint prostheses in many orthopaedic hospitals in Russia in the mid of 1990s and early 2000s [3]. However, national literature lacks the analysis of outcomes of clinical application with follow up period over 10 years. The data of individual clinics can be of interest which accumulate patients with hip pathologies and perform long follow up of patients after arthroplasty.

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The purpose of the study was to evaluate the long term outcomes of total hip arthroplasty with RM Classic acetabular component.

Material and Methods

Study design: single center retrospective clinical study.

674 primary and revision procedures using RM Classic cup (Mathys Ltd Bettlach, Switzerland) were performed in 586 patients in the period from 1997 till 2007.

Nosocomial mortality (acute heart failure and pulmonary insufficiency, thromboembolism, cerebral accident) was reported for 14 (2.1%) patients mainly of elderly and old age with femoral neck fractures. Deep infection within 6 to 48 months requiring removal of the prosthesis was observed in 6 (0,9%) cases. Cup revisions due to recurrent dislocations — in 4 (0.6%) cases. In other 31 (4.6%) cases well fixed acetabular components with early signs of polyethylene wear were removed during revision procedures for reason of stem instability and breakage of ceramic heads. All patients mentioned above were excluded from the study.

138 patients died in the period from 9 months to 20 years for reasons not related to the arthroplasty. 104 patients were not available for follow up due to changed place of residence, absence of telephone contact or reluctance of patients and relatives to cooperate.

Thus, remaining 289 patients were included into the present study who underwent 328 surgeries of hip joint arthroplasty. The group consisted of 196 women (226 prostheses) and 93 men (102 prostheses).

Mean age of patients at the moment of surgery was 46.5 (±0.69) years, ranging from 15 to 73. Indications for surgical procedure are given in the Table 1.

All surgeries were performed through the posterolateral Kocher-Langenbeck approach by the same team of surgeons. RM Classic cups with outer diameter in the range from 46 to 62 mm were implanted. Cup size distribution depending on patients' gender is demonstrated in figure 1. Average quantity of peripheral diverging screws used for additional primary fixation was four.

Table 1

Indications for THA in patients of the present study

Diagnosis	Number of procedures	%
Primary hip osteoarthritis	137	41,8
Dysplastic hip osteoarthritis	74	22,6
Avascular femoral head necrosis	22	6,7
Posttraumatic hip osteoarthritis	11	3,3
Rheumatoid polyarthritis	13	4,0
Post-infectious hip osteoarthritis	1	0,3
Tumors	4	1,2
Femoral neck fracture	51	15,5
Revision arthroplasty	15	4,6
Total	328	100,0

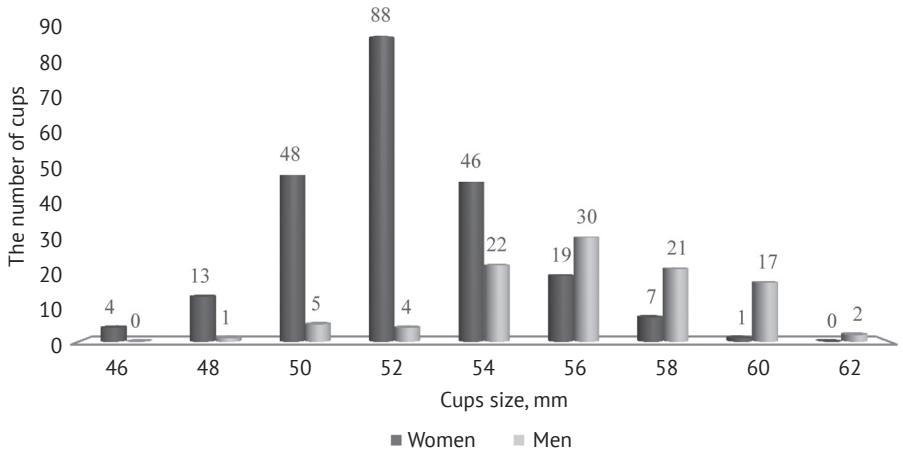

Fig. 1. Distribution of cups size depending on the gender of patients

Most often RM cup was combined with uncemented Mathys femoral components: CBH (Zweymuller type) — 138, CBC (Spotorno type) — 80, as well as with the similar stems of domestic and international manufacturers.

Prosthesis heads with diameter of 28mm were used in all surgeries with prevalence of aluminum ceramic components in 204 (62.1%) cases while CoCrMo heads were implanted in 124 (37.9%) cases.

Distribution of procedures per year is given in figure 2.

Patients were examined in 3, 6 and 12 months postoperatively, then once every five years. In 15 years postoperatively the prosthesis was controlled once in 2-3 years. The authors performed analysis of X-rays of the operated joints. Special attention was given to prosthesis head de-centration, appearance of osteolysis along Charnley zones I-III, deformity and failures of diverging screws and cranial cup migration. Harris hip score was used for evaluation of functional status.

Statistical analysis

Statistical processing of the data was done with Microsoft Excel, XLSTAT 2018.4 add-in and IBM SPSS Statistics v. 22 software (SPSS Inc., Chicago, Il, USA). Descriptive statistics with indication of the mean value and the standard error of arithmetical mean was used to reflect the overall features of reference parameters. Data with normal distribution (after verification by the Kolmogorov–Smirnov test)

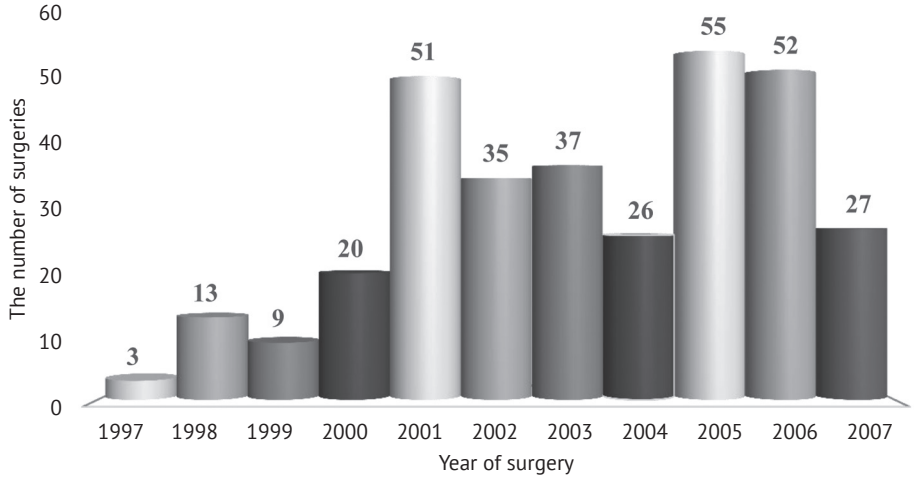

Fig. 2. Distribution of procedures per years

was analyzed by the Kaplan–Meier estimator allowing to reliably evaluate the criteria for large samples given patients' withdrawal from the study. The analysis was supplemented by statistical calculations of the standard error and confidence intervals. Mantel-Cox chi-square (p) was used to identify the statistical significance of variances for RM Classic cup survival with ceramic-on-poly and metal-on-poly bearings.

Results

Follow up period varied from 10 to 20 years with average of 14.4 (±0.14). Revision with replacement of RM Classic cup due to polyethylene wear, its aseptic instability and pelvis osteolysis was considered the endpoint of the follow up. Only 28 (8.5%) revisions were performed for above indications. Mean age of patients at the moment of revision was 58±2 years.

One RM Classic cup was revised in the early period (up to 5 years). Faults in surgical technique were the cause for early aseptic instability (Fig. 3).

8 revisions were made in mid-term period (from 6 to 10 years). Careful analysis of initial X-rays demonstrated high pseudo-acetabulum positioning of RM Classis cup in two female patients with dysplastic hip osteoarthrosis and congenital hip dislocation. In one of patients with posttraumatic hip osteoarthrosis the polyethylene cup was implanted into the area of chronic rupture of the pelvic ring. Aseptic instability developed in 8 years (Fig. 4). In other cases accelerated polyethylene wear resulted from the increased abduction angle ≥45° during cup insertion.

Finally, in the late period from 11 to 20 years, 19 prostheses were revised in 18 patients (one female patient underwent bilateral procedure). Inguinal or gluteal pain, mainly start pain or pain and at the end of the day after significant physical activity, were the indications for revision. The majority of patients used a walking stick. Polyethylene wear was marked on the X-rays by de-centration and cranial displacement of head components. Practically no signs of innominate bone osteolysis in Charnley zones I and

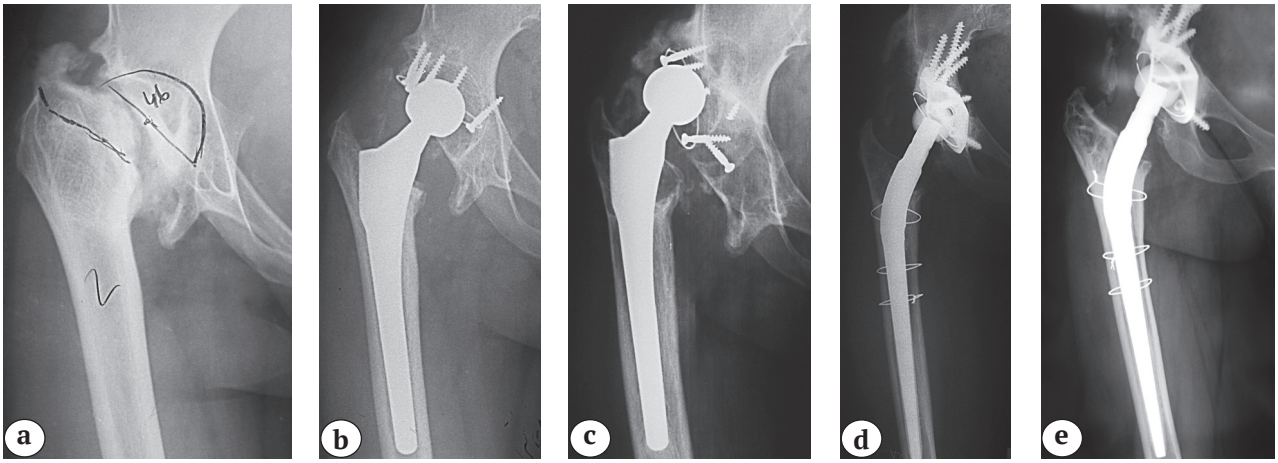

Fig. 3. X-rays of female patient 16 y.o.:
a — progressive dysplasia of the right hip joint of type IV, avascular necrosis of femoral head after open reduction and corrective osteotomies in childhood (1998);
b — total hip arthroplasty RM-HJD, 46 mm diameter cup placed 4 cm above the anatomical position laterally, short diverging screws (1999);
c — aseptic instability, cup migration with screws breakage in 4 years (2003);
d — revision arthroplasty (2003);
e — late follow up in 13 years, stable prosthesis, no evident signs of polyethylene wear, Brooker I heterotopic ossification (2016)

II should be specifically noted. Polyethylene wear products were accumulated usually in the proximal femur in the area of the greater trochanter. Extensive osteolysis of pelvic bone was observed only in one case with formation of W.G. Paprosky III defect along with a stable cup (Fig. 5).

Excluding the above case RM Classic cup revisions did not pose any complications. Due to low coefficient of porosity of the outer TiC coating the surrounding pelvic bone did not grow into it but was rather building up on the coating thus solid osteointegration of cups was never observed. That's why after removal of diverging screws the authors drilled out the polyethylene by hemispherical cutters and easily split titanium and bone leaving the pegs unremoved. Hemispherical cups with multiple holes for additional introduction of 3-5 6,5 mm cancellous screws for secure primary stability were used in all cases as revision acetabular components. There was no need for bone grafting.

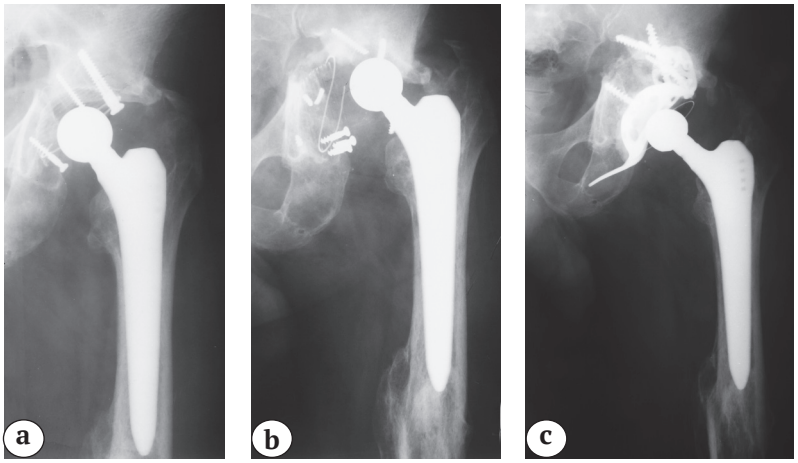

Fig. 4. X-rays of male patient 26 y.o.:
a — total hip arthroplasty RM-CBH due to posttraumatic coxarthrosis with nonunion of the pelvic ring rupture;
b — aseptic instability and failure of cup in 8 years;
c — revision arthroplasty with bone grafting

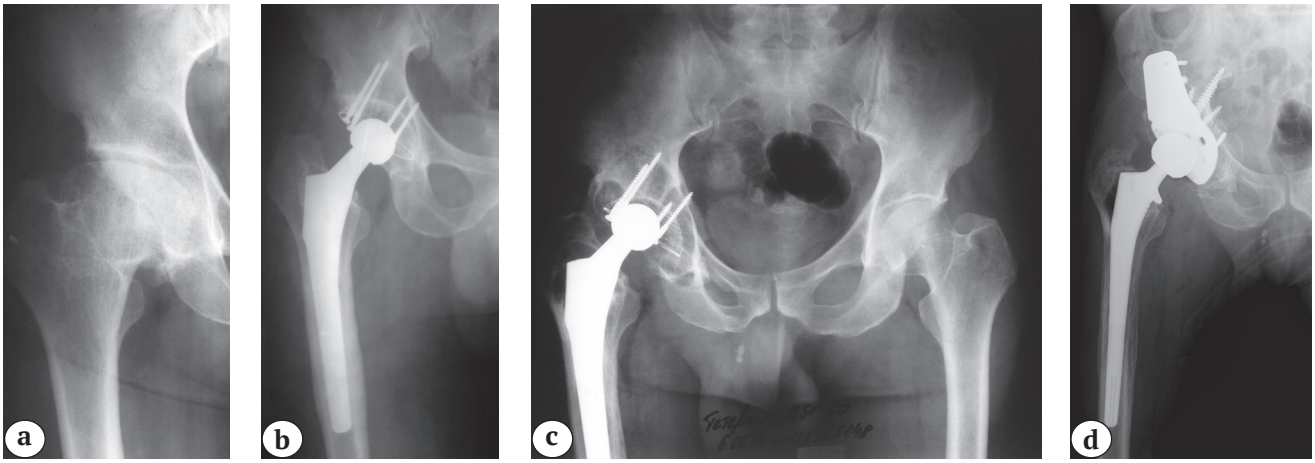

Fig. 5. X-rays of male patient 48 y.o.:
a — secondary coxarthrosis following Perthes disease in childhood;
b — total hip arthroplasty RM-HJD (1997);
c — extensive osteolysis with formation of type III defect by W.G. Paprosky;
d — revision arthroplasty with supportive augment of trabecular metal (2017)

The authors analyzed primary diagnosis of 27 patients with wear and aseptic loosening of RM cup. It was reported that in 15 (53.6%) patients the primary arthroplasty was performed due to progressing hip dysplasia of types III and IV with congenital hip dislocation after reconstructive procedures performed in the childhood (Table 2).

Table 2

Primary diagnosis in patients with RM Classic aseptic loosening

Primary diagnosis	Number of revisions	%
Dysplastic hip osteoarthritis	15	53,6
Primary hip osteoarthritis	4	14,3
Avascular necrosis of the femoral head	2	7,1
Fracture of the femoral neck	2	7,1
Posttraumatic hip osteoarthritis	1	3,6
Post-infectious hip osteoarthritis	1	3,6
Revision hip arthroplasty	3	10,7
Total	28	100,0

The authors undertook a separate analysis for RM Classic cup survival with aluminum ceramic and with CoCrMo heads. Ceramic-on-poly bearing demonstrated high survival of 94.9% (±0.02), 95% CI 90.9– 98.8 (Fig. 6) by 18 years postoperatively.

Values of metal-on-poly bearings were reliably lower (p = 0.001, Mantel-Cox criteria) where RM Classic cup survival did not exceed 79.4% (±0.054), 95% CI 70.0–88.9 (Fig. 7). Thus, overall 15-years survival rate of acetabular components in the covered group of 328 THAs was 92.5% (±0.017), 95% CI 89.4–95.8. Mean functional Harris score was 88,6.

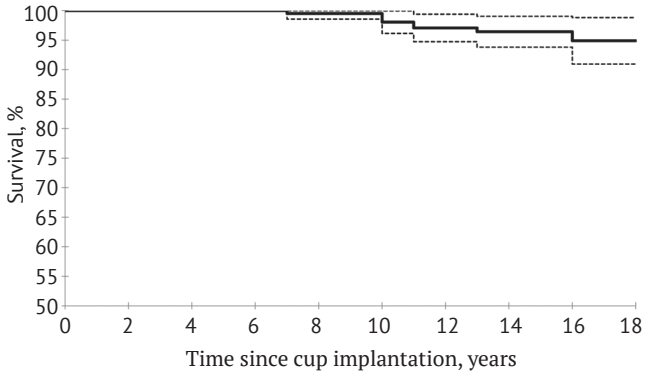

Fig. 6. RM Classic cup survivorship in ceramics-on-poly bearing with wear and aseptic loosening as the end point of the study

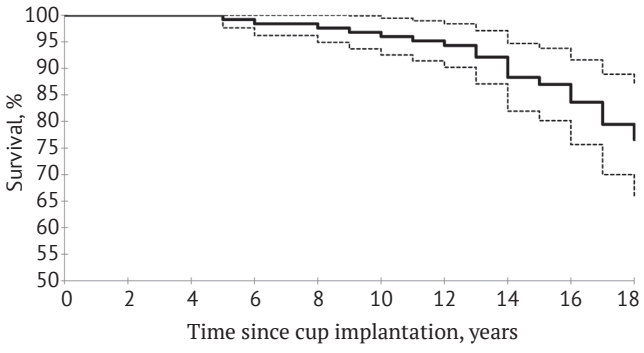

Fig. 7. RM Classic cup survivorship in metal-on-poly bearing with wear and aseptic loosening as the end point of the study

Discussion

Polyethylene acetabular components with external porous coating (titanium particles, mesh, hydroxyapatite powder) for uncemented fixation appeared in the mid of 1980s [4]. Such non-modular components had their advantages and drawbacks [5, 6] as compared to conventional metal cups combined with polyethylene inlays. Lower cost and absence of such complications like dissociation of inlay and backside wear were undoubtedly the advantages. Inability to control depth of implant positioning and impossibility to perform polyethylene exchange keeping well fixed cup in place were designated as drawbacks.

Cups geometry represented a hemisphere with a cranial slope (beveled cup), thus the recommended abduction angle should not exceed 30° [6]. Formation of holes for pegs and screws especially in overweight patients required high skills of operating surgeon and sophistication in technique in contrast to a smooth metal cup. Probability of errors during orientation of acetabular components increased and learning curve lengthened. All early revisions resulted from procedure faults (primary procedures were performed in 1997-2000 during mastering of the surgical technique).

Relatively young age of 46.5 years at the moment of primary arthroplasty was one of the peculiarities of the examined patients. Due to absence of government financing arthroplasties using imported implants were performed either on a commercial basis or in the framework of clinical trials of medicinal agents. Young age of the patients in itself is considered as a risk factor while usually accompanied by high physical activity and accelerated wear of non-crosslink ultra-high molecular weight polyethylene [7, 8].

More than 50% of revisions were performed in patients with hip osteoarthrosis and severe hip dysplasia as the indication for initial surgery. Authors from Prof. W.Siebert's group reported features of RM Classic cup implantations for Crowe III and IV dysplasia [9].

15-years survival rate of the cups in the present study series with revision due to polyethylene wear and aseptic loosening as the end point was 92.5%. This value can be considered high for the non-crosslink polyethylene in the patients of young and middle age. Obtained results fully correspond to data of other researchers [9, 10]. Statistically significant difference in survival rates of RM Classic cup was reported depending on the used bearing (ceramics-on-poly vs metal-on-poly) — 94.9% and 79.4% respectively. These values do not correlate to the data of Australian register where it's demonstrated that metal heads surpass the results of ceramics on non-crosslink polyethylene*.

There are numerous indications in the literature that pelvis osteolysis is less pronounced during wear of non-modular acetabular components in contrast to polyethylene inlays of conventional metal cups [11, 12, 13, 14]. In the present series the authors observed only one defect of type IIIa by W.G.Paprosky which required replacement of roof and posterior column by a trabecular metal augment. Usually polyethylene debris "drained" along the active articular space to the proximal femur causing its destruction and loosening of the stem.

Removal technique of well fixed RM Classic cups is very simple even in the late follow up [15]. Absence of extensive pelvic defects made the absolute majority of revisions atraumatic and low-cost. Primary hemispherical modular components with crosslink polyethylene

* Australian Orthopaedic Association National Joint Replacement Registry. Hip, Knee & Shoulder Arthroplasty: 2018 Annual Reports. Режим доступа: https://aoanjrr.sahmri.com/.

on metal or ceramic heads were implanted in all cases without bone grafting.

The results of the present study demonstrated good 15-years survival rate of the monoblock polyethylene RM Classic cup with titanium coating ranging from 89.4% to 95.8% in the worst and the best scenarios, respectively. Tribology-wise ceramics-on-poly in the present series significantly surpassed metal-on-poly bearings. Acetabular components proved its high efficiency in cases of complex primary and revision arthroplasties in young and middle-aged patients.

All revisions of RM Classic cup performed within 10 years after initial surgery were related to technical errors made in the process of the learning curve. Absence of backside wear significantly reduced the risk of osteolysis making the following revision simple and low-cost.

Patients included into the present retrospective clinical study need regular dynamic control aiming at timely detection of arising complications and prevention of increasing destruction of peri-prosthetic tissues.

Publication ethics

All patients provided voluntary consent for publication of the clinical cases.

Conflict of interests: the authors declare that there are no competing interests.

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Authors' contribution

Danilyak V.V. — study design, literature search, data acquisition, analysis and interpretation of the data and the writing of the manuscript.

Klyuchevsky V.V. — data acquisition, analysis and interpretation of the data.

Molodov M.A. — data acquisition, analysis and interpretation of the data.

Goryunov E.V. — study design, the literature search and review, data acquisition and analysis, writting text of the manuscript.

Marchenkova K.V. — data acquisition and analysis, statistical processing of the data, writting text of the manuscript.

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