Bipolar Hemiarthroplasty *vs* Total Arthroplasty of the Patients with Aseptic Necrosis of the Femoral Head

20 year retrospective study

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We evaluated 1541 patients with aseptic necrosis of the femoral head who underwent prosthetic surgery over a period of 20 years and assessed each implant survival rate depending on the surgucal technique used. The patients were divided into two groups. The first group contained patients with stage II and III of aseptic necrosis, while the second group contained patients with coxarthrosis secondary to the aseptic necrosis of the femoral head. In 20 years, the revision of the bipolar prosthesis in patients with NACF stage III was rated at 1.65%, p=0.0005 and the total prosthesis was rated 7.41%, in patients with secondary NACF coxarthrosis, in spite of 3.98% which was in patients with NACF, p=0.002. The cotyloid was the most frequent cause for the bipolar prosthesis revision and the aseptic loosening of the cup was the most common cause for the total prosthesis revision in patients with secondary NACF coxarthrosis.

Keywords: aseptic necrosis of the femoral head, hemiarthroplasty, bipolar prosthesis, coxarthrosis, total hip arthroplasty

Osteonecrosis (ON) was first described in 1738 by Alexander Munro [1]. In 1794, James Russell, professor of clinical Surgery in Edinburgh, published his classic essay on bone necrosis, which was one of the first detailed pathological descriptions of this disease. A clear distinction between septic and aseptic necrosis has not been done so far, but the majority of his cases were septic [2]. Between 1829 and 1842, Jean Cruveilhier, the famous French anatomist, described the overall deformation of the femoral head as a late complication of trauma, probably due to vascular lesions [3, 4]. Kraglund in 1886 and Konin in 1888 described this state in depth [5]. However, in 1936, Freund exposed the first detailed description of bilateral aseptic necrosis of femoral heads [6]. Between 1934 and 1949 Phemister and his associates wrote a number of classic articles on etiology and pathogenesis of aseptic necrosis [7-9].

Experimental part

This study is retrospective observational. We evaluated a group of 1541 patients hospitalized in the Clinic of Orthopedics - Traumatology, Rehabilitation Hospital, Iasi. The data was collected from the observation charts in the hospital records and registry of operations from 01.01.1997 to 01.04.2017. Three groups of patients were surveyed in this study:

- Group I with 486 cases, of which 368 are men and 118 are women, patients with stage II or III of left, right or bilateral aseptic necrosis of the femoral head (NACF);
- Group II, with 1055 cases, of which 496 are men and 559 are women, patients with coxarthrosis secondary to the left, right or bilateral aseptic necrosis of the femoral head (NACF).

Any specific type of intervention or prosthesis were collected from the hospital records of the surgery protocols.

Based on the assumption that there is a difference between the effectiveness of the intervention with bipolar prosthesis hemiarthroplasty and total arthroplasty of the hip (ATS) in patients with NACF, this study wants to highlight aspects related to: the causes of maintenance depending on the diagnosis and the implant used, the rate of revision of the implant according to the diagnosis and etiology.

Results and discusions

1541 cases were investigated and divided into two groups. Patients in group II had a significantly higher age mean overall: 63.14 to 48.36 in group I, $p < 0.0000001$, and gender: men 62.39 years in group II, to 47.72 years in group I, $p < 0.0000001$; 63.08 years for women in group II compared to 51.28 years in group I, $p < 0.0000001$.

During 20 years, the frequency of cases with stage III, III/IV developed relatively similar to the cases with stage IV, except for the years 2003, 2005, 2006 an 2011, when there was a significant increase in cases of stage IV NACF(fig.1).

During 20 years, for men, the frequency of cases of stage III, III/IV NACF did not differentiate significantly from the cases of stage IV NACF, with the exception of 2011, when the frequency of cases with NACF stage IV was significantly higher than the cases with stage III, III/IV of NACF (10.08% to 5.71% with stage III, III/IV, $p=0.01$) (fig.2).

During 20 years, for women, the frequency of cases with stage III, III/IV of NACF was not significantly different from the cases of NACF stage IV, except for 2009, when the frequency of cases with NACF stage III, III/IV was significantly higher that the NACF cases with stage IV (16.1% compared to 9.66% with stage IV, $p=0.002$) (fig.3).

In group I, the comparison of the frequency of diagnoses by gender showed that: left and right hip cases of NACF occurred significantly more frequently in women: NACF of the left hip 33.05% in women, while 22.28% in men, $p=0.008$; NACF of the right hip, 43.22% compared to 25%, $p=0.0001$; but the cases of bilateral NACF occurred significantly more frequently in men: 52.72% to 23.73% in women, $p<0.00001$ (table 1).

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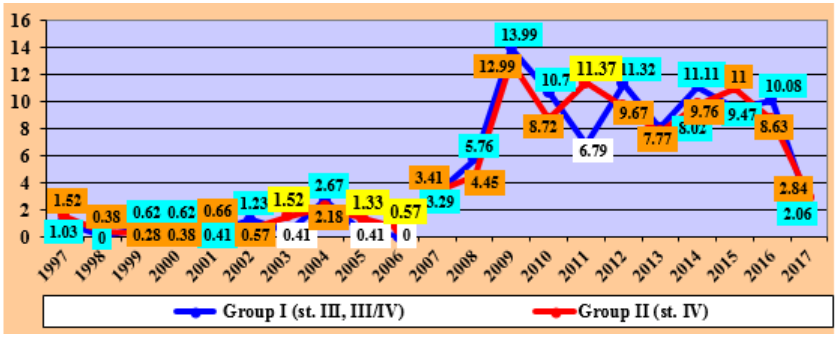

Fig. 1. Frequency of cases per year, depending on the stage of disease in the two groups

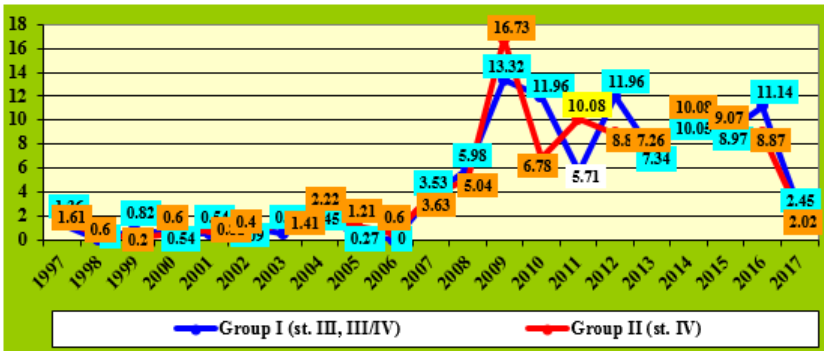

Fig. 2. Frequency of cases per year, depending on the stage of disease in men

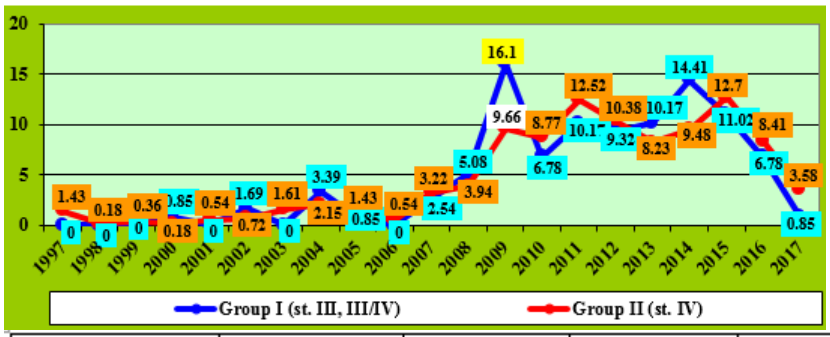

Fig. 3. Frequency of cases per year, depending on the stage of disease in women

Diagnosis	Men		Women		Total		P
Left hip NACF	82	*22.28*	39	**33.05**	121	24.90	**0.008**
Right hip NACF	92	*25.00*	51	**43.22**	143	29.42	**0.0001**
Bilateral NACF	194	**52.72**	28	*23.73*	222	45.68	**< 0.00001**
Total	368	100	118	100	486	100	

Table 1
THE FREQUENCY OF CASES AFTER DIAGNOSIS IN GROUP I, BY GENDER

Revision cause	Group I		Group II		Difference semnification (p)
	n	%	n	%	
Right cotyloid	6	**1.23**	1	*0.09*	**0.001**
Left cotyloid	1	0.21	0	0.00	0.07
Aseptic loosening prosthesis	22	**4.53**	17	*1.61*	**0.0004**
Septic loosening prosthesis	2	0.41	5	0.47	0.39
Cup aseptic loosesning	5	1.03	8	0.76	0.48
Stem aseptic loosening	3	0.62	6	0.57	0.50
Stem septic loosening	1	0.21	1	0.09	0.27
Periprosthetic fracture	4	0.82	6	0.57	0.29
Bipolar periprosthetic fracture	0	0.00	3	0.28	0.12
Damage insert	0	0.00	1	0.09	0.25
Damage insert and head	1	0.21	1	0.09	0.27
Prosthetic dislocation	9	**1.85**	9	*0.85*	**0.04**
Bipolare prosthetic dislocation	6	**1.23**	0	*0.00*	**0.0002**
Cup septic loosening	1	0.21	1	0.09	0.27
Septic bipolar loosening	5	**1.03**	0	*0.00*	**0.0006**
Aseptic bipolar loosening	0	0.00	1	0.09	0.25
Total with revision	66	**13.58**	60	*5.69*	**< 0.00001**
Without revision	420	*86.42*	995	**94.31**	

Table 2
THE FREQUENCY OF REVISION CAUSES IN THE TWO GROUPS

It was found that in group I, there were significantly more frequent cases that needed revision: 13.8% to 5.69% in group II, $p<0.00001$ (table2), of which turned out to be significantly more frequent cases of: aseptic prosthesis loosening 4.55% to 1.1% in group II, $p=0.0004$ (table 2); prosthetic strain: 1.85% to 0.85% in group II, $p=0.04$ (table 2); right cotyloid: 1.23% to 0.09% in group II, $p=0.001$ (table 2); bipolar prosthesis strain: 1.23% to 0% in group II, $p=0.0002$ (table 2); septic bipolar loosening 1.03% compared to 0% in group II, $p=0.0006$ (table 2).

The comparison of the frequency of cases by etiology in the two groups, according to sex highlighted the following:

In group I: the frequency of cases with idiopathic etiology was significantly higher in women: 54.24% compared to 43.21% in men, p=0.02; frequency of cases with corticosteroids was significantly higher in men: 35.33% against 26.27% in women, p = 0.03; the frequency of cases with traumatic etiology, was significantly higher in women: 4.24% to 1.09% in men, p = 0.01; the frequency of cases with chronic alcohol abuse, and other causes, had no significant gender differences (fig. 4).

In group II: the frequency of cases with idiopathic etiology was significantly higher in women: 46.61% against 40.61% in men, p=0.02; the frequency of cases with chronic alcohol abuse was significantly higher in men: 30.71% against 14.46% in women, p<0.00001; the frequency of cases with traumatic etiology was significantly higher in women: 26.76% to 17.94% in men, p=0.0003; the frequency of cases with corticosteroids, or other causes, had no significant gender differences (fig. 4)

In group II, there were significantly more frequently recorded cases of left total hip arthroplasty (43.03% compared to 15.23% in group I, p<0.00001) and of total hip arthroplasty (49.67% compared to 23.66% in group I, p<0.00001), and in group I were found significantly more cases of hemiarthroplasty of the left hip (23.87% compared to 0.19% in group II, p<0.00001) hemiarthroplasty of the right hip (25.1% compared to 0.47% in group II, p<0.00001) total revision arthroplasty (7.41% compared to 3.98% in group II, p=0.002) and bipolar revision (1.655% compared to 0.19% in group II, p=0.0005).

Regarding to the frequency of the surgical types, in group I it was found that: in men were significantly more frequent the cases of left hip hemiarthroplasty (26.9% compared to 14.41% in women, p=0.003) in women were significantly more frequent the cases of: total revision arthroplasty (16.95% versus 4.35% in men, p<0.00001); bipolar prosthesis revision (4.24% compared to 0.82% in men, p=0.006); revision, bleeding reduction and fixation (2.54% compared to 0.54% in men, p=0.03); revision arthriplasty of the rod (1.69% to 0.27% in men, p = 0.04); revision surgical reduction (0.85% compared to 0% in men, p = 0.04); In group II, no significant differences were found between the sexes judging by the common types of surgery.

Age ranged in group I from 27 to 84 years, while in the second group, between 28 and 85 years, but the average age of the group II was significantly higher (63.14 years compared to 48.36 years in group I, p <0.0000001) (table 3).

The comparison of the frequency of uncemented prostheses in the two age groups revealed the following significant differences: in group I there are significantly more frequently used the non-cemented prosthesis in the 26-35 years age group (11.78% vs. 1, 1% in the group II, p <0.00001), 36-45 (35.34% compared to 18.58% (table 3), in group II, p<0.00001) and in the 46-55 years age group (33.97% compared to 18.58% in group II, p <0.00001) (table 3). In group II, there are used significantly more frequent the non cemented prostheses in the age groups of 56-65 years old (40.31% compared to 13.97% in group I, p = 0.0001), 66-75 years (30.08% to 4.38% in group I, p <0.00001) and 76-85 years old (5.2% to 0.55% in group I, p = 0.0005) (table 3).

The comparison of the frequency of use of the cemented prostheses in the two age groups, revealed the following significant differences: in group I, there are significantly more frequently used the cemented prostheses for the age groups of 26-35 years old (6.48% vs. 0% in group II, p <0.00001), 36-45 (34.07% compared to 2.03% in group II, p <0.00001) and 46-55 years old (36.11% compared to 11, 39% in group II, p <0.00001) (table 3); in group II, the cemented prosthesis were significantly more frequently used in the age 56-65 years age group (34.43% compared to 19.44% in group I, p = 0.001), 66-75 years (37.97% compared to 12.04% in group I, p <0.00001) and 76-85 years old (14.18% versus 1.85% in group I, p = 0.0002) (table 3).

From the total of 1541 cases, in 1019 cases (66.3%) non-cemented prostheses have been used, in 486 cases (31.54%) had cemented prostheses and 36 cases (2.34%) had other devices (table 4).

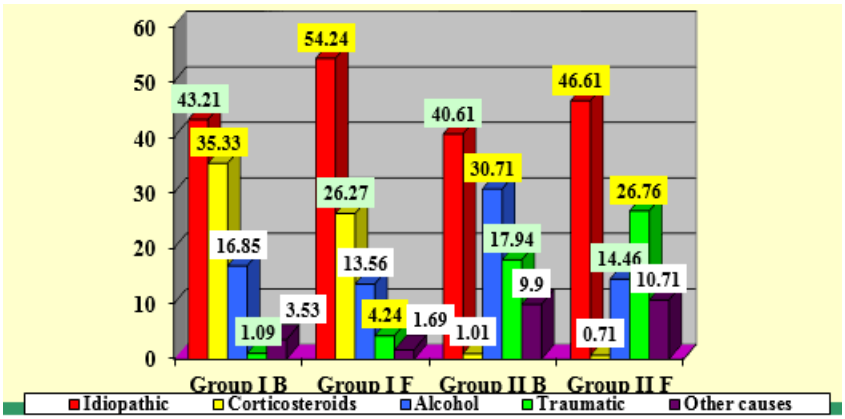

Fig. 4. Significant differences between the sexes judging the frequency of cases by etiology

Age groups	Prosthesis types								
	Non-cemented (%)			Cemented (%)			Other devices (%)		
	Group I	Group II	p	Group I	Group II	p	Group I	Group II	p
26-35	**11.78**	1.10	<0.00001	**6.48**	0.00	<0.00001	0.00	0	
36-45	**35.34**	4.72	<0.00001	**24.07**	2.03	<0.00001	**15.38**	0	**0.03**
46-55	**33.97**	18.58	<0.00001	**36.11**	11.39	<0.00001	15.38	8	0.25
56-65	13.97	**40.31**	<0.00001	19.44	**34.43**	0.001	**53.85**	24	**0.04**
66-75	4.38	**30.08**	<0.00001	12.04	**37.97**	<0.00001	15.38	40	0.07
76-85	0.55	**5.20**	0.0005	1.85	**14.18**	0.0002	0.00	**28**	**0.02**
Total	100.00	100.00		100.00	100.00		100.00	100	

Table 3
DIFFERENCES BETWEEN GROUPS ON COMMON TYPES OF PROSTHESIS BY AGE

Nr.	Name of the intervention	Non-cemented		Cemented		Other	
		%	p	%	p	%	p
1	Total left hip arthroplasty	34.25		36.83		*0.00*	<0.00001
2	Total right hip arthroplasty	*39.25*	0.0002	48.97		*2.78*	<0.00001
3	Revision arthroplasty of the cup	*0.59*	0.0004	*1.03*	0.01	5.56	
4	Left hip hemiarthroplasty	10.30		*2.67*	<0.00001	*0.00*	0.02
5	Right hip hemiarthroplasty	10.89		*3.09*	<0.00001	2.78	0.06
6	Revision of blood reduction and fixation	*0.00*	<0.00001	*0.21*	<0.00001	33.33	
7	Total revision arthroplasty	*3.73*	<0.00001	*4.53*	<0.00001	50.00	
8	Revision arthroplasty of the stem	0.39		0.82		0.00	
9	Ablation prosthesis revision	0.29		0.00		0.00	
10	Bipolar revision	0.20	<0.00001	1.65		0.00	
11	Surgical reduction revision	*0.00*	<0.00001	*0.21*	0.005	2.78	
12	Spacer revision	0.10		0.00		0.00	
13	Orthopedic reduction	*0.00*	<0.00001	*0.00*	0.005	2.78	
	Total	1019 (66.13%)		486 (31.54%)		36 (2.34%)	

Table 4
SIGNIFICANT DIFFERENCES IN THE FREQUENCY OF EACH TYPE OF PROSTHETIC INTERVENTION

Lee et al have shown that 23% of BPH patients showed evidence of migration of the bipolar head after 10 years of follow-up and mentioned every revision in these patients [11]. Although they found no evidence of osteolysis in patients, the polyethylene wear is still a growing concern in the risk of osteolysis in time. Diwanki reported on the results of the 25 conversions of HPB to ATS with pain relief and functional improvement at a mean of 7.2 years [10]. The subsequent dislocation of the total prosthesis was the most common postoperative complication.

The proportion of failures caused by the migration of the stem or the decrease of its stability was the same or even higher than the proportion of failures of bipolar cups. Articles comparing HPB and ATS using the same type of uncemented stem in order to exclude the influence of the stability of it on the survival of the inner bipolar head, were also published. Lee et al. compared the results of 40 HPB and 31 ATS with the same uncemented stem in the treatment of NACF stage III Arlet Ficat [10]. The authors have shown that patients with HPB had statistically worse clinical outcomes than the ones in group ATS. The incidence of thigh pain was comparable in both groups, but the group of HPB has an incidence of 20% of the groin pain and a 15% incidence of gluteal pain.

Due to poor clinical results and high incidence of migration, the authors concluded that ATS was a better solution than HPB in the treatment of NACF stage III Ficat Arlet. Instead, Chan presented the results of 28 patients treated with HPB, for NACF with bilateral hip and with ATS for the other contralateral hip [11]. Stage III NACF Ficat Arlet has been indicated for HPB and stage IV of NACF for ATS. He published that there is no difference observed in patient satisfaction, clinical evaluation, groin and thigh pain, osteolysis, dislocation or revisions between the two groups [11].

Lachiewicz and Desman [12] reported the results of HPB on NACF performed in 31 hips in 24 patients with only 48% good or excellent results at a mean of 4.6 years. Nishii et al [13] have reviewed 45 cases of bipolar NACF replacements and found femoral endocortical osteolysis in 26 (58%) of the hips, with an average of 5 years follow-up.

Our results are consistent with those of recent studies showing that the survivorship of ATS in NACF is significantly improved to the levels observed in ATS for coxarthrosis. Before 1993, the survival rate was reported 38% after 10 years. Since then, the survival rate increased to over 80%, while the rest remained lower in comparison to the arthritis [13 - 16]. A recent study of Bedard et al. [18] based on 80 ATS metal on polyethylene in NACF has shown that in 10 years the survival rate is 100% for the aseptic loosening and 93% for the major revision. Issa et al. [19] studied 78 cases of uncemented ATS for NACF and concluded that the survival rates on the aseptic loosening after 5 years are 98% and after 10 years are 96.5%. Another study, by Kim et al. [20] included 74 who underwent ATS with ceramic or metal and crosslinked polyethylene head for NACF. The survival rate for the aseptic loosening was 96.6% after 10 and 16 years. The cup was the main reason for major revision, in accordance with previous data [19, 21]. Good osteointegration of the stem allows the keeping of this component during the major revision [23, 24].

Few studies have compared the ATS results between NACF and arthritis [14,15,16, 24]. In 1989 Saito et al. [15] reported a comparison between 29 patients with NACF and 63 cases of arthritis of the hip treated with cemented ATS. After a median follow-up of 7 years, the functional results were lower in the group with NACF, which had a 28% increased rate of revision compared to 6% in the group of arthritis ($P < 0.005$) [15], leading the authors to the conclusion that patients with NACF were at high risk of failure of ATS. Another comparison of NACF and coxarthrosis was reported in 1999 by Ortiguera et al. [16], which included 94 patients in each group. A Charnley prosthesis of 22 mm was used in both groups. After an average follow-up of 17.8 years, the survival on the major revision did not differ significantly between the two groups. However, the aseptic loosening, especially of the stem, was more common in the group with NACF, which also had a high frequency of revision for the sprain [7 vs 1; $p<0.05$]. Revision was more common in the subgroup of patients with coxarthrosis, who were younger than 50 years, with a major revision rate of 50%, with aseptic loosening as the reason for revision in 79% of the cases [17]. In 2008, Steinberg et al. [24] reported a significantly higher rate of major revision of the NACF than in coxarthrosis, mainly due to a large number of major revision of the femoral component.

Byun et al. reported ATS results for the thirg ceramic on ceramic generation on young active patients with NACF. They assessed 56 ATS of this kind in 41 patients with a mean age of 25.6 years (range 16-29 years). At a mean follow-up of 7.7 years (range, 6-8, 5 year) osteolysis was not observed and no revision was necessary. Moreover, no ceramic fracture did occur during the follow-up [25].

Solarino et al. reported long-term results of the third generation ceramic on ceramic ATS on patients with NACF. They used a large ceramic head (32 mm) for 68 ATS ceramic on ceramic in 61 patients with NACF (median age 49.9 years, range 29-72 years). At a mean follow-up of

12.9 years (range 11-15 years) two revisions were made, one for periprosthetic infection and one of excessive abduction of the acetabular component. No ceramic fracture or osteolysis was observed [26].

Cuckler [27] concludes a rate of 7.2% cumulative review of nine years in the Australian register, and says that rate, erosion of the femoral head aswell as other joint metal – metal complications, should encourage surgeons to use resurfacing ATS with caution and states that *refurbishing of the hip is contraindicated in cases of special avascular necrosis with cysts bigger than1 cm in diameter.*

Conclusions

During the 20 years revision in patients with bipolar prosthesis NACF in stage III was at a rate of 1.5%, $p=0.0005$ and for total prosthesis 7.41% in patients with coxarthrosis secondary to NACF compared to 3.98% in patients with NACF, $p=0.002$. The cotyloid was the most frequent cause in the revision of the bipolar prosthesis and the loosening of the aseptic cup was the most common cause in the revision of the total prosthesis in patients with coxarthrosis secondary to NACF.

References

1.STEINBERG M.E, STEINBERG D.R, În KOO K. H, MONT M, JONES L.C., Springer, 2014, p.3.
2.RUSSELL J, Clin Orthop, No. 130, 1978, p.5.
3.DUBOIS EL., COZEN L., JAMA, No.174, 1960, p.108.
4.JONES JR. JP., ENGLEMAN EP., Arthritis Rheum., No. 9, 1966, p.728.
5.KONIG F., Dtsch Z Chir., No. 27, 1988, p.99.
6.FREUND E., Ann Surg., No. 104, 1936, p.100.
7.PHEMISTER DB., Surg Gynecol Obstet, No.59,1934, p.415.
8.PHEMISTER DB., Arch Surg., No.41, 1940, p.436.
9.PHEMISTER DB., J Bone Joint Surg Am., No. 31, 1949, p. 55.
10.DIWANJI SR., KIM SK., SEON JK., PARK SJ., YOON TR., J Arthroplasty, No. 23(7), 2008, p.1009 - 1015.
11.CHAN YS., SHIH CH., Clin Orthop Relat Res, 2000, No. 379: p. 169-177.
12.LACHIEWICZ PF., DESMAN SM., J Arthroplasty, No. 3, 1988, p. 131.
13.NISHII T., SUGANO N., MASUHARA K., ET AL. Clin Orthop, 1995, No. 316, 1995, p.112.
14.RITTER MA., MEDING JB., Clin Orthop RelatRes., No. 206, 1986, p. 139–146.
15.SAITO S., SAITO M., NISHINA T., OHZONO K., ONO K., Clin Orthop Relat Res., No. 244, 1989, p. 198–207.
16.ORTIGUERA CJ., PULLIAM IT., CABANELA ME., J Arthroplasty, No. 14, 1999, p. 21–28.
17.NICH C., COURPIED JP., KERBOULL M., POSTEL M., HAMADOUCHE M., J Arthroplasty, No. 21, 2006, p. 533–540.
18.BEDARD NA., CALLAGHAN JJ., LIU SS., GREINER JJ., KLAASSEN AL., JOHNSTON RC., J Arthroplasty, No. 28, 2013, p. 1192–1199.
19.ISSA K., NAZIRI Q., RASQUINHA V., MAHESHWARI AV., DELANOIS RE., MONT MA., J Bone Joint Surg Am., No. 95, 2013, p. 1845–1850.
20.KIM SM., LIM SJ., MOON YW., KIM YT., KO KR., PARK YS., J Arthroplasty, No. 28, 2013, p. 504–509.
21.MIN BW., SONG KS., BAE KC., CHO CH., LEE KJ., KIM HJ., J. Arthroplasty, No. 23, 2008, p. 902–910.
22.CANTIN O., VISTE A., DESMARCHELIER R., BESSE JL., FESSY MH., Orthop Traumatol Surg Res., No.101, 2015, p. 775–780.
23.CINOTTI G., DELLA ROCCA A., SESSA P., RIPANI FR., GIANNICOLA G., Orthop Traumatol Surg Res., No.99, 2013, p. 30–36.
24.STEINBERG ME., LAI M., GARINO JP., ONG A., WONG KL., Orthopedics, No. 31, 2008, p. 360.
25.BYUN JW., YOON TR., PARK KS., SEON JK., J Arthroplasty, No.7, 2012, p. 1337.
26.SOLARINO G, PIAZZOLLA A, NOTARNICOLA A, MORETTI L, TAFURI S, DE GIORGI S, MORETTI B., J Orthop Traumatol, No. 1, 2012, p. 21.
27.CUCKLER JM. Orthopedics, No. 34(9), 2011, p. 439–441.

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