Acta Clin Croat 2023; 62:652-658
doi: 10.20471/acc.2023.62.04.10

Original Scientific Paper

UNCEMENTED *VERSUS* HYBRID TOTAL HIP ARTHROPLASTY: REVISION RATE, REVISION RISK FACTORS, AND REVISION CAUSE

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SUMMARY – Total hip arthroplasty (THA) is one of the most successful surgeries. Cemented, uncemented and hybrid methods of implant fixation can be used with different chances for implant survival. There is no consensus on the best fixation method. The aim of the study was to compare the groups of uncemented and hybrid implants according to survival, revision risk and revision cause. Until October 2015, a total of 199 THA uncemented and hybrid (uncemented acetabulum, cemented femur) implants implanted during the 1995-2003 period that had revision or last x-ray taken at least seven years after the initial operation were included in the study. Revision rate, risk factors, revision cause and revised components were investigated. A significant difference was found in the revision rate, i.e., 48 (27.9%) in uncemented group *versus* 13 (48.1%) in hybrid group (p=0.032). The relative risk for revision was significantly higher (RR=1.72; 95% CI: 1.09-2.73; p=0.019) in hybrids, most often due to loosening (p=0.004). The linear wear of polyethylene was the main cause of revision in uncemented THA (p<0.001). In hybrid group, larger revision replacing the femoral component was most often performed. Uncemented THA showed a lower revision rate, lower revision risk, and required 'minor' revisions compared to the hybrid ones.

Key words: *Total hip arthroplasty; Revision; Survival*

Introduction

Since the first implantation of the Charnley's total hip, total hip arthroplasty (THA)[1] has become one of the most successful surgical procedures. Many authors report excellent results in reducing pain and improving function and quality of life in patients with osteoarthritis of the hip. In 2007, Lancet presented THA as a 'surgery of the century'[2], and today it is still one of the most effective surgical procedures.

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Received November 24, 2021, accepted December 20, 2021

In the last two decades we can see rapid development of implants (different models, fixation methods and materials) and surgical techniques (different surgical approaches to the hip joint). The goal of developing surgical techniques and new types of implants is to shorten the duration of surgery, achieve the best possible functional outcome, and use materials that do not have negative effects, allowing the maximum implant survival[3-6].

According to fixation method, we can use cemented, uncemented, hybrid (uncemented acetabulum in combination with cemented femur) and reverse hybrid (cemented acetabulum and uncemented femur)[7]. There are controversies in choosing the best fixation method. At first, aseptic loosening was connected to only ce-

mented endoprostheses as 'cement disease'[8], and an attempt was made to develop and use uncemented endoprostheses[9]. Unfortunately, further research showed that loosening also occurred in other fixation modalities[10,11]. Despite the above, an 'uncemented paradox' is described[12] (increase in the use of uncemented endoprostheses, despite results from registers that show association between the use of uncemented endoprostheses and increased revision risk especially in older age groups)[12-18]. In some studies, an early revision due to periprosthetic fracture was observed in uncemented fixation model[19-21]. Since there is no consensus on the best fixation method, the aim of this study was to compare the groups of uncemented and hybrid THA with respect to survival, revision risk and revision cause.

Material and Methods

This retrospective study included a total number of 199 THA. Uncemented and hybrid (uncemented acetabulum, cemented femur) implants implanted during the 1995-2003 period that had revision or last x-ray taken at least seven years after initial operation were included in the study until October 2015. In the 1995-2003 period, Intraplant HI cup model of THA was used for hip replacement at a single institution. Uncemented cup was used in combination with uncemented or cemented femoral component. All data on the patient (age, weight, gender), diagnosis (coxarthrosis, congenital hip dysplasia, posttraumatic or autoimmune disease), surgery (surgery time, blood loss, surgeon) and endoprosthesis (uncemented or hybrid and size of the implants) were collected. Data on revision, time to revision, reason for revision and revised component were also collected. The last available x-rays were digitalized using known diameter of the femoral head and Photoshop CS6 program. Acetabular cup tilt, position of the femoral component, polyethylene (PE) linear wear and acetabular anteversion were measured and calculated from x-rays. Revision rate, risk factors, revision cause and revised implant components were investigated. Only patients with all data available were included in the study. Ethical approval was obtained from the University of Zagreb School of Medicine.

Table 1. Differences in fixation type, gender, age groups, diagnosis and femoral position between revision groups

		Without revision		Revision		p
		n	Row N %	n	Row N %	
Fixation type	Uncemented	124	72.1	48	27.9	0.032
	Hybrid	14	51.9	13	48.1	
Gender	Male	52	65.0	28	35.0	0.278
	Female	86	72.3	33	27.7	
Age group (years)	<50	36	58.1	26	41.9	0.165
	50-54	25	73.5	9	26.5	
	55-59	14	60.9	9	39.1	
	60-64	31	79.5	8	20.5	
	65-69	20	76.9	6	23.1	
	≥70	12	80.0	3	20.0	
Diagnosis	Coxarthrosis	90	70.3	38	29.7	0.203
	Congenital hip dysplasia	26	76.5	8	23.5	
	Posttraumatic	8	47.1	9	52.9	
	Autoimmune disease	14	70.0	6	30.0	
Femoral component position	Satisfactory	113	69.3	50	30.7	0.955
	Valgus	12	70.6	5	29.4	
	Varus	12	66.7	6	33.3	

Fisher-Freeman-Halton's exact test

Table 2. Differences in revision cause and revised prosthesis components between uncemented and hybrid THA

		Fixation type				p
		Uncemented		Hybrid		
		n	Column N %	n	Column N %	
Revision cause	PE wear	30	62.5	2	15.4	0.004
	Loosening	12	25.0	10	76.9	
	Infection	4	8.3	1	7.7	
	Fracture	2	4.2	0	0.0	
Revised prosthesis component	PE	25	52.1	2	15.4	<0.001
	All components replaced	3	6.3	4	30.8	
	Femur	2	4.2	6	46.2	
	Acetabulum	14	29.2	0	0.0	
	Extraction	4	8.3	1	7.7	

Fisher-Freeman-Halton's exact test; THA = total hip arthroplasty; PE = polyethylene

Statistical methods

The Kolmogorov-Smirnov test was used to test the hypothesis of normal distribution. Continuous variables were expressed as median (interquartile range [IQR]) and evaluated using the Mann-Whiney U test. Categorical variables were expressed as frequencies (percentages) and evaluated using Fisher-Freeman-Halton's exact test. All values of $p<0.05$ were considered significant. Statistical software IBM SPSS Statistics version 27.0 (https://www.ibm.com/analytics/spss-statistics-software) was used in all statistical procedures.

Results

A significant difference was found in the revision rate, i.e., 48 (27.9%) in uncemented *versus* 13 (48.1%) in hybrids (p=0.032). The relative risk for revision in hybrids was significantly higher (relative risk [RR]=1.72; 95% confidence interval [CI]: 1.09-2.73; p=0.019) (Table 1).

The most frequent cause of revision among hybrid implants was loosening, i.e., 10 (76.9%) *vs*. 12 (25.0%) (p=0.004) (Table 2). There was a significant difference in revised prosthesis components. In hybrid implants, revision of femoral or both components was most frequently performed (p<0.001). In uncemented implants, PE linear wear was the main revision cause and PE was the part that was most often revised in uncemented implant group (Table 2).

Gender, age group, diagnosis and femoral position did not show significant risk factors for revision in uncemented and hybrid group (Table 3).

In uncemented group, PE linear wear was a significant risk factor for revision (p<0.001) (Table 4) and 'minor' revision (PE replacement) was most often performed (Table 2).

In hybrid group, no significant revision risk factors were detected (Table 5). 'Major' revision replacing the femoral component was most often performed (Table 2).

Discussion

When observing the success or failure of THA, it is necessary to define parameters that determine failure. Definition itself can be made according to several criteria such as revision rate, radiological signs (radiolucent zone, shift of the implant component, fracture of bone cement) or clinical signs (pain, poor function, movement restriction). Wejkner and Stenport published 4% failure in the cases where only revision was assessed, and 8% failure when other clinical and radiographic parameters were included[22]. In our study, we showed a high revision rate ranging from 48 (27.9%) in uncemented *versus* 13 (48.1%) in hybrid implants (p=0.032). Poor survival rate of the Intraplant HI total hip prosthesis used in our study was expected due to sterilization of PE in an oxygen environment, which leads to early PE failure. A high revision rate could

Table 3. Differences in gender, age groups, diagnosis and femoral position between revised and non-revised uncemented and hybrid THA

		Uncemented				p	Hybrid				p
		Without revision		Revision			Without revision		Revision		
		n	Row N %	n	Row N %		n	Row N %	n	Row N %	
Gender	Male	49	69.0	22	31.0	0.492	3	33.3	6	66.7	0.236
	Female	75	74.3	26	25.7		11	61.1	7	38.9	
Age group (years)	<50	35	62.5	21	37.5	0.227	1	16.7	5	83.3	0.358
	50-54	22	78.6	6	21.4		3	50.0	3	50.0	
	55-59	13	61.9	8	38.1		1	50.0	1	50.0	
	60-64	27	84.4	5	15.6		4	57.1	3	42.9	
	65-69	16	76.2	5	23.8		4	80.0	1	20.0	
	≥70	11	78.6	3	21.4		1	100.0	0	0.0	
Diagnosis	Coxarthrosis	81	74.3	28	25.7	0.154	9	47.4	10	52.6	1.000
	Congenital hip dysplasia	24	77.4	7	22.6		2	66.7	1	33.3	
	Posttraumatic	7	46.7	8	53.3		1	50.0	1	50.0	
	Autoimmune disease	12	70.6	5	29.4		2	66.7	1	33.3	
Femoral component position	Satisfactory	99	71.7	39	28.3	1.000	14	56.0	11	44.0	0.222
	Valgus	12	70.6	5	29.4		0	0.0	0	0.0	
	Varus	12	75.0	4	25.0		0	0.0	2	100.0	

Fisher-Freeman-Halton's exact test; THA = total hip arthroplasty

Table 4. Differences between revised and non-revised uncemented THA according to body weight, operation time, acetabular anteversion, PE linear wear and overall follow-up time

Uncemented THA		n	Minimum	Maximum	Percentile			p
					25th	50th (Median)	75th	
Body weight (kg)	Without revision	124	35	126	70.00	78.50	89.75	0.879
	Revision	48	46	110	66.25	77.50	90.00	
Operation time (min)	Without revision	124	45	240	60.00	70.00	85.00	0.338
	Revision	48	40	125	60.00	75.00	85.00	
Acetabular anteversion	Without revision	124	0,02	0,56	0.12	0.19	0.24	0.284
	Revision	48	0,02	0,83	0.10	0.19	0.22	
PE linear wear	Without revision	124	0,10	14,80	1.30	1.95	2.78	<0.001
	Revision	44	0,10	18,90	2.51	4.45	9.00	
Overall follow-up (months)	Without revision	124	85	226	107.25	124.00	144.00	0.094
	Revision	43	87	202	117.00	142.00	158.00	

Mann-Whitney U test; THA = total hip arthroplasty; PE = polyethylene

Table 5. Differences between revised and non-revised hybrid THA according to body weight, operation time, acetabular anteversion, PE linear wear and overall follow-up time

Hybrid THA		n	Minimum	Maximum	Percentile			p
					25th	50th (Median)	75th	
Body weight (kg)	Without revision	14	56	110	67.25	74.00	81.25	0.609
	Revision	13	65	113	68.50	75.00	85.50	
Operation time (min)	Without revision	14	55	110	63.75	72.50	92.50	0.883
	Revision	13	55	90	67.50	80.00	85.00	
Acetabular anteversion	Without revision	14	0.04	0.35	0.08	0.15	0.20	0.662
	Revision	13	0.00	0.36	0.09	0.16	0.26	
PE linear wear	Without revision	14	0.25	3.45	1.43	1.78	2.26	0.805
	Revision	11	0.10	9.25	1.30	1.55	2.45	
Overall follow-up (months)	Without revision	14	100	205	123.50	140.00	192.25	0.411
	Revision	11	111	219	128.00	157.00	170.00	

Mann-Whitney U test; THA = total hip arthroplasty; PE = polyethylene

also be explained by the method of data collecting. In the study we included only total hips with revision and data without revision but with follow up longer than seven years. It is expected that using this method, we included implants that had revision but missed some of the implants that had good result and did not have a checkup or x-ray done. Despite limitations, the significant difference between the uncemented and hybrid group was clearly shown and relative risk for revision in hybrids was significantly almost two times higher.

Some implant survival studies define failure from the aspect of revision, while loosening, mechanical defects, or other factors consider susceptible to misinterpretation. Decision to do the revision is a result of patient and surgeon opinion. Sometimes, revision can be done on well-fixed implants, whereas sometimes implants showing loosening are not revised[23]. In our study, we investigated failure from revision aspect (revision rate and risk of revision in two groups) but we also defined the reason for revision, as well as the implant component that was revised.

The term 'cement disease' is basically loosening of the cemented implants. The cause is unclear but it is known that the reaction to cement and PE particles leads to osteolysis of bone[24], with or without loosening of implants[25]. Results of this study showed that the most common cause of revision among hybrid implants compared to uncemented was loosening, i.e., 10 (76.9%) *vs*. 12 (25.0%) (p=0.004). The benefits of biological fixation in uncemented implants are clear[26,27]. According to some authors, the onset of stable fixation in uncemented implants is not accompanied by its loosening over time[28]. Results of our study show that PE linear wear was the most common reason for the revision in uncemented implants, supporting the opinion that loosening is rarely observed. This means that a 'minor' revision with PE replacement is usually sufficient for good revision result.

In their study, Bjørgul *et al*.[29] compared all cemented and reverse hybrid implants. No radiological or clinical differences were found. No differences were observed in survival in 12- to 14-year follow up either. Later, a 17-year follow up study showed lower survival of cemented compared to uncemented implants[30]. In our study, we compared uncemented and hybrid implants and overall better results obtained in uncemented THA. Although uncemented implants are more expensive than cemented ones[31,32], results of our study suggest that this higher cost of uncemented implants could be justified with lower revision rate and the likelihood that if the revision becomes necessary, this revision will be 'minor' (lower cost) revision. In conclusion, uncemented endoprostheses show better survival, lower revision risk, and require 'minor' revisions compared to the hybrid ones.

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Sažetak

UZROCI, ČIMBENICI RIZIKA I UČESTALOST REVIZIJE BESCEMENTNIH U ODNOSU NA HIBRIDNE TOTALNE ENDOPROTEZE KUKA

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Zamjena kuka ugradnjom totalne endoproteze (TEP) smatra se jednom od najuspješnijih operacija. Prema metodi fiksacije razlikujemo cementirane, bescementne i hibridne proteze koje imaju različite izglede za preživljenje implantata. Zasad ne postoji konsenzus o najboljoj metodi fiksacije. Cilj je bio usporediti skupine bescementnih i hibridnih TEP kuka s obzirom na preživljenje, rizik revizije i razlog revizije. U studiju je do listopada 2015. uključeno ukupno 199 bescementnih i hibridnih (bescementni acetabulum, cementirani femur) TEP kuka ugrađenih od 1995. do 2003. godine. Do listopada 2015. godine uključene su revidirane proteze ili one kod kojih je posljednja rendgenska snimka učinjena najmanje sedam godina poslije početne operacije. Istražen je postotak revizija, čimbenici rizika, uzrok revizije i revidirana komponenta TEP. Uočena je značajna razlika u postotku revizija: 48 (27,9%) kod bescementnih naspram 13 (48,1%) hibrida (p=0,032). Relativni rizik za reviziju kod hibrida je bio značajno veći (RR=1,72; 95% CI: 1,09-2,73; p=0,019), najčešće zbog razlabavljenja (p=0,004). Linearno trošenje polietilena glavni je uzrok revizije kod bescementnih TEP (p<0,001). U hibridnoj skupini najčešće je rađena „veća“ revizija, mijenjana je femoralna komponenta. Bescementne TEP pokazuju nižu stopu revizije, manji rizik revizije i zahtijevaju „manju” reviziju u odnosu na hibridne.

Ključne riječi: *Totalna artroplastika kuka; Revizija; Preživljenje*