

Long-term survival of cemented versus uncemented total hip arthroplasty in the treatment of acute femoral neck fracture: A retrospective observational study with a mean 10-year follow-up

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Research article

Keywords: Total hip arthroplasty, Cemented, Uncemented, Harris Hip Score, Survival

Posted Date: February 27th, 2020

DOI: <https://doi.org/10.21203/rs.2.24764/v1>

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Abstract

Background Despite the increased use of uncemented total hip arthroplasty (UTHA), there is little evidence of its superiority over cemented total hip arthroplasty (CTHA). The purpose of this retrospective study was to compare the long-term survivorship and Harris Hip Scores (HHSs) of CTHA versus UTHA in the treatment of acute femoral neck fractures (FNFs). **Methods** Data involving 224 hips (CTHA, n= 112; UTHA, n=112) that underwent primary surgery in our medical institutions during 2005-2017 were analysed retrospectively. The primary endpoint was the risk of all-cause revision. The difference in the risk of all-cause revision between groups was assessed by Kaplan-Meier survival analysis with a log-rank test and Cox regression analysis. **Results** The mean follow-up from surgery was 10 years (range, 3 - 13 years). Kaplan-Meier estimated that the 10-year implant survival was 98.1% (CI: 96.1–98.5) in the CTHA group and 96.2% (CI: 95.2–97.3) in the UTHA group ($p = 0.030$). The adjusted Cox regression analysis demonstrated a lower risk of revision in CTHA than in UTHA (hazard ratio [HR] = 1.4, 95% confidence interval [CI] = 1.1-2.6, $p = 0.000$). At the final follow-up, significant differences were detected in HHS (85.10[±12.21] for CTHA vs. 79.11[±13.19] for UTHA). **Conclusion** This retrospective analysis demonstrates that CTHA has superior survival to UTHA, with a significantly reduced revision risk and higher functional outcome scores. Further follow-up is necessary to verify whether the CTHA advantage persists over time.

Background

Femoral neck fractures (FNFs) are severe injuries and may lead to long-term disability[1, 2]. For displaced fractures, cemented or uncemented total hip arthroplasty (CTHA or UTHA, respectively) is frequently used[3]. Implant failure secondary to primary THA has become a concern and is eventually addressed using THA revision, contributing to a revision rate as high as 15 to 35%[2, 4]. Nevertheless, there is a paucity of literature on the long-term survivorship and Harris Hip Scores (HHSs) following primary CTHA or UTHA in the Asian population[5].

Although previous literature has reported implant survival and HHSs after primary CTHA or UTHA, they have either focused on complication rates or primary diagnoses[6, 7]. Additionally, the reported results for implant survival and HHSs vary widely and are mainly attributable to differences in inclusion and exclusion criteria, sample sizes, and the length of follow-up[8, 9]. Data on long-term implant survival and HHSs remain lacking. Furthermore, limited literature has reported implant survival; however, most of these reports have been subject to the length of follow-up[10]. A previous study reported by Lazarinis showed approximately a revision rate of 7.5% after 10 years for CTHA[11]. More recent studies have almost all focused on the application of UTHA and have shown exceptional results, with 5-year survival rates approaching 90-100%[6, 12]. However, these first-rate results have not been verified in other studies, e.g., Swarup reported a 10-year survival rate of 87% for UTHA[8].

To date, there remains limited evidence for the superiority of CTHA over UTHA in terms of implant survival and HHS. As THA volume continues to increase, understanding the two indexes occurring throughout the

postoperative period will be especially valuable. Hence, we performed this retrospective study to compare the long-term survivorship and HHS of CTHA versus UTHA in the treatment of acute FNFs in the Asian population.

Methods

Study population

Between January 2005 and August 2017, data involving patients who underwent unilateral primary CTHA or UTHA for acute FNFs were collected from our tertiary academic medical centre. Manufacturer details of the stems and cups employed in THA are shown in Table 1. The main exclusion criteria included inadequate study-related data, secondary CTHA or UTHA, bed-ridden status prior to primary CTHA or UTHA, pathological fracture secondary to malignant diseases, incapacity to follow instructions, osteoarthritis or rheumatoid arthritis, active hip infection, tumour, injury-severity score (ISS) > 10, multiple injuries, severe cognitive impairment, drug or alcohol abuse, and an American Society of Anesthesiologists (ASA) score of IV or V.

Based on our criteria, a total of 112 patients (112 hips) with complete data were identified from our medical centre and were included in the survival analysis, as shown in Figure 1. All surgical procedures were carried out at our medical centre by 3 high-volume orthopaedists (WY, XZ, MZ), all of whom were experienced with arthroplasties. The indications for surgery included FNFs (OTA/AO, 31-B1, 2, 3). A consistent protocol of antibiotics (cefazolin, 1.0 g; ivgtt, bid, Baomanbio, Shanghai, China) was used perioperatively for 3 days. Furthermore, an anticoagulant regimen (enoxaparin sodium, Clexane 4000 AXa IU, ivgtt; qd, AVENTIS, Shanghai, China) was used for each patient without contraindications for 1 month, starting at admission. A similar rehabilitation programme was used for each patient. Early mobilisation was advocated, with weight bearing as tolerated. The follow-up data included the risk of all-cause revision and the HHS. Follow-up occurred 1 year, 2 years, and every 2 years after primary CTHA or UTHA. The primary endpoint was implant survival.

Statistical analysis

Implant survival was calculated from the initiation of primary CTHA or UTHA until the date of final follow-up or revision surgery, whichever occurred first. Signs of cemented or uncemented stem loosening were evaluated by 2 co-authors in accordance with previous reports[13, 14], and the assessment of the cups was performed using Charnley zones[15]. Revision was defined as the removal or exchange of any component[7]. Failure was defined as revision of the primary CTHA or UTHA for any cause. The difference in risk of revision between groups was assessed by Kaplan-Meier survival analysis with a log-rank test and Cox regression analysis. A Cox proportional hazard model was utilised to estimate the hazard ratio (HR) and corresponding 95% confidence interval (CI) for survival. The Kaplan-Meier method and Cox analysis were performed with adjustments for age, sex, body mass index (BMI), bone mineral density (BMD), and ASA score. Categorical variables were compared using Pearson's χ^2 test or Fisher's

test, as appropriate. Statistical analyses were performed using SPSS (version 24.0, IBM Corp, Armonk, NY, USA). The level of significance was set at $p = 0.05$.

Results

Overall survivorship

For the survival analysis, cases with at least a 7-year follow-up were included. There were 102 (45.1%) males and 124 (54.9%) females, with a median age of 68.8 (60-77) years. At the time of analysis, the median follow-up was 10.2 (7-13) years. The median interval to THA after FNF was 8.4 (1-15) days. No statistically significant differences were detected regarding baseline characteristics between groups. A study flow chart is illustrated in Figure 1, and the baseline data are demonstrated in Table 2.

The results of the survival analysis are shown in Figure 2. CTHA had a significantly better 10-year survival of 98.1% (CI: 96.1–98.5) than that estimated at 10 years for UTHA. UTHA had an estimated 10-year survival of 96.2% (CI: 95.2–97.3). Statistically significant differences existed in the 10-year survival for CTHA versus UTHA ($p = 0.030$). Cox regression demonstrated similar results; patients treated with a UTHA had a 1.4-fold increase in risk of revision after adjusting for age, sex, BMI, BMD, and ASA score.

Functional outcomes

The mean HHS increased from 55.74 (± 10.32) prior to surgery to 85.10 (± 12.21) at the final follow-up for CTHA patients and 56.16 (± 11.24) to 79.11 (± 13.19) for UTHA patients. Approximately 72% of the patients who were treated with CTHA or UTHA had a satisfactory HHS at the final follow-up. Table 3 presents the values for each follow-up after surgery. The mean HHSs in the CTHA and UTHA groups were 85.12 (± 8.22) and 84.73 (± 6.21) one year after surgery, respectively ($p = 0.104$). From 2 years after surgery to the final follow-up, CTHA yielded higher HHSs than UTHA (all $p < 0.05$). Especially at the final follow-up, CTHA patients had a significantly higher HHS of 85.10 (± 12.21) compared to UTHA patients, who had an HHS of 78.11 (± 13.19) ($p = 0.000$).

Discussion

This retrospective study provides evidence that CTHA has superior survival to UTHA, with the revision risk being significantly decreased and the HHS being higher. To our knowledge, this is a relatively large sample size study involving survivorship between CTHA and UTHA following acute FNFs.

Several limitations exist in the present study. First, the retrospective nature of our study tends to lead to errors in evaluating patient characteristics and could be associated with limited power to draw robust conclusions. Second, selection bias exists objectively and is difficult to avoid because of the exclusion of a large number of undesirable cases. Third, follow-up outcomes are likely to be influenced by patient-level confounders and the experience of the orthopaedists. Nonetheless, abiding by arthroplasty guidelines

and having a high-volume environment ensure that we optimise the treatment of patients. Despite the drawbacks mentioned above, the error margin seems to be acceptable in the present setting.

A growing but still extremely limited body of literature assessing survivorship between CTHA and UTHA showed a survival advantage for CTHA[16]. In the current report, we observed a reduced survival for UTHA, with a 10-year survival approaching 96.2%. However, a 10-year survival of 57% was reported in a previous study involving 10 cases treated with secondary UTHA[7]. In addition, a 10-year survival of 77% occurred in 20 UTHA cases[17]. The phenomena of low 10-year survival for UTHA was possibly triggered by poor patient survival data and a small sample size. Junnila et al.[18] reported a brand-level comparison of CTHA based on the Nordic Arthroplasty Register Association (NARA) database and showed that implant survival was above the acceptable limit for 10-year survival (95.8%). Laaksonen et al.[19] reported 10,113 primary UTHAs and demonstrated that the overall survivorship up to 8 years was 94.4-96.25%. However, a recent study showed no significant difference in survival between CTHA and UTHA[10]. This may partially be attributed to the low numbers (22 hip) in this study. Recently, 10-year survival after THAs has been reported in with large samples (i.e., more than 100 hips). Davis et al.[20] reported a 10-year survival of 95% in a series of 104 CTHA-treated hips. Additionally, a 10-year survival of 97% in a series of 112 CTHA-treated hips was noted in a study by Norambuena et al.[21]. In Europe, the 10-year survival for CTHA was higher than that for UTHA[22, 23]. The superiority of hip stability after CTHA over that after UTHA has been reported due to the low stress transfer and good fusion of the cement-bone interface[7, 24]. The between-component mechanical wear introduced by edge loading is lower in CTHA than in UTHA[24]. Along with our findings, the results reported by these studies seem to confirm that CTHA is the preferred alternative for managing an acute FNF.

This study showed that CTHA had a lower revision risk than UTHA. Revision risks for CTHA reported in earlier studies tend to be miscellaneous, with revision risks ranging from 3.2% to 11%[24, 12, 25]. Despite the low revision risk for CTHA in the present study, when previous reports assessing revision risks in CTHA are regarded as a reference, the revision risk is consistent with previously reported values[25]. Pedersen et al.[4], who used the Nordic Arthroplasty Registry Association database, found that UTHA rather than CTHA in patients younger than 55 years had more short-term revisions owing to dislocation, periprosthetic fracture and infection. Recently, several reports assessing CTHA have shown a lower revision risk at the midterm follow-up compared with those assessing UTHA[26, 27]. UTHA appears to be associated with an increased risk of revision following primary THA[28].

Conclusions

The long-term results reported in this study support an increasing body of evidence that CTHA is associated with increased survival benefits, lower revision risk, and higher HHSs compared with UTHA. Hence, when proceeding with UTHA in patients with an acute FNF, the patients should be informed of the increased potential for failure, revision, and poor HHS. Furthermore, when interpreting the differences in survival benefit or revision risk for CTHA and UTHA, strategies to improve implant survival should be directed based on baseline characteristics, such as age, sex, BMI, BMD, and ASA score.

Abbreviations

CTHA: cemented total hip arthroplasty; UTHA: uncemented total hip arthroplasty; FNF: femoral neck fracture; HR: hazard ratio; CI: confidence interval; HHS: harris hip score; BMI: body mass index; BMD: bone mineral density; ISS: injury severity score; ASA: American Society of Anesthesiologists; SD: Standard deviation.

Declarations

Acknowledgements

The authors would like to thank Hang Yu for her help with retrieval of data.

Funding

Funding for this research was received from the National Natural Science Foundation of China (Grant No. 81971315).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Authors' contributions

XH performed the data collection and analysis and participated in manuscript writing. WY and JL performed the database setup and statistical analysis. MZ and GH performed the operations. XZ participated in the study design and coordination and helped to draft the manuscript. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the Medical Ethics Committee (The First Affiliated Hospital, Sun Yat-sen University), and an exemption from informed consent was obtained from our responsible Investigational Ethics Review Board.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1 Manufacturer details of stems and cups employed in THA

Patients, No.	Stem	Cup
CTHA		
54	Exeter ¹ ,	Exeter ¹ , Elite ⁴ , IP/SP1 ³ ,
32	Spectron EF ² ,	Contemporary ¹ , Marathon ⁴ ,
26	Lubinus SP2 ³ ,	Exeter X ³ Rimfit ¹ ,
UTHA		
75	Corail ⁴ ,	Reflection uncemented ² ,
39	Filler ⁵ ,	Trident ¹ , Igloo ⁵ ,

¹Stryker, ²Smith & Nephew, ³Waldemar LINK, ⁴DePuy, ⁵Biotechni. CTHA: cemented total hip arthroplasty; UTHA: uncemented total hip arthroplasty

Table 2 Patient demographics and outcomes

Variable	CTHA(n=112)	UTHA(n=114)	p-value
Sex, No. M/F	52/60	50/64	0.698 ^a
Age at surgery(years)	68.75±8.36	69.02±8.22	0.171 ^b
BMI kg/m ²	25.62±8.34	26.14±7.53	0.106 ^b
BMD	-2.74±0.65	-2.75±0.43	0.212 ^b
Side, No. left/right	54/58	59/55	0.595 ^a
Comorbidities			0.757 ^c
Hypertension	37	40	
Diabetes mellitus	34	28	
Hypertension and Diabetes mellitus	11	14	
Pulmonary	8	10	
Cerebrovascular accident	9	7	
Cardiopathy	7	8	
Anemia	6	7	
Mechanism of injury			0.537 ^c
Traffic-related injury	31	27	
Injury by falling	60	64	
Tamp injury	21	23	
ASA Index			0.313 ^c
I	23	32	
II	57	52	
III	32	30	
Fracture types, OTA/AO			0.518 ^c
31-B1	36	31	
31-B2	57	63	
31-B3	19	20	
Surgical approach			0.696 ^c
Anterior	54	52	
Anterolateral	58	62	
Time to surgery (days)	8.00±7.32	8.00±6.75	0.241 ^b
Head size, mm			0.962 ^c
28	32	35	
30	34	27	
32	28	34	
36	20	18	
Preoperative HHS	55.74±10.32	56.16±11.24	0.528 ^b
Follow-up time (years)	10.33±3.15	10.21±3.01	0.312 ^b

^aAnalysed using the chi-square test; ^bAnalysed using an Independent-Samples t-test;

^cAnalysed using the Mann-Whitney test. CTHA: cemented total hip arthroplasty; UTHA: uncemented total hip arthroplasty; HHS: Harris hip score; ASA: American Society of Anaesthesiologists; BMI: body mass index; BMD: bone mineral density.

Table 3 Long-term follow-up functional outcomes

HHS, year(s) postoperatively	CTHA(n=112)	UTHA(n=114)	p-value
1	85.12±8.22	84.73±6.21	0.104*
2	89.53±8.42	86.37±7.26	0.021*
4	86.15±8.37	84.30±8.25	0.014*
6	87.62±7.35	85.16±9.20	0.012*
8	85.57±9.26	80.38±7.67	0.010*
10	85.48±11.03	79.61±12.15	0.010*
At final follow-up	85.10±12.21	78.11±13.19	0.000*

*Statistically significant values.

CTHA: cemented total hip arthroplasty; UTHA: uncemented total hip arthroplasty; HHS: Harris hip score.

Figures

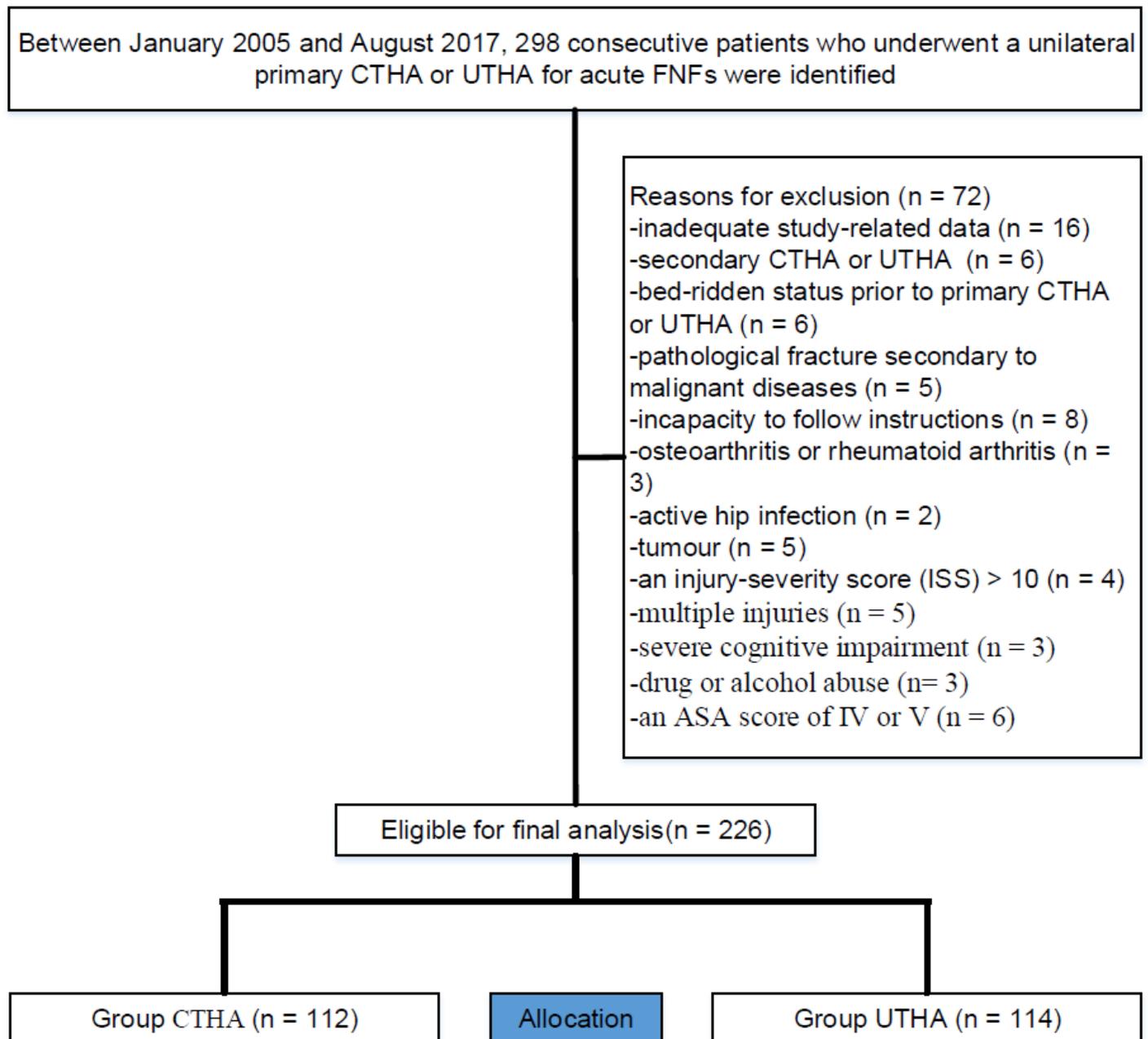


Figure 1

Flow diagram demonstrating methods for identification and exclusion of study to assess the survivorship of CTHA and UTHA in the treatment of acute femoral neck fracture (FNF).

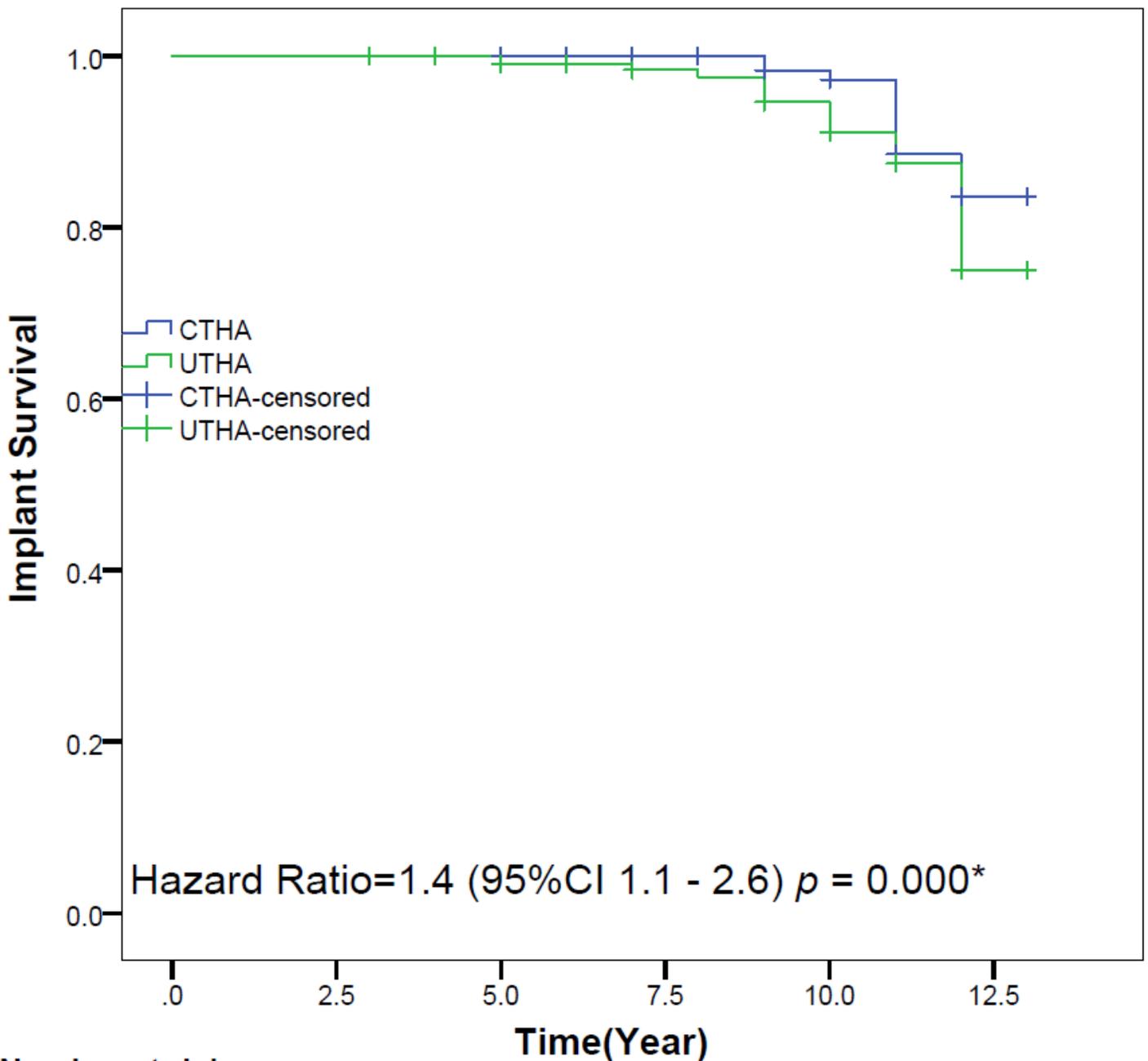


Figure 2

Kaplan-Meier survival analysis comparing CTHA with UTHA using the risk of all-cause revision as the primary endpoint. The cumulative survival rate at 10 years after surgery was observed to be significant between groups ($p = 0.030$). *HR was calculated using the Cox proportional hazards model, with

adjustment for age, sex, body mass index (BMI), bone mineral density (BMD), and ASA score as covariates and CTHA/UTHA surgery as the time-dependent factor.