



University of Dundee

Acetabulum-Only Revision Total Hip Arthroplasty Is Associated With Good Functional Outcomes and Survivorship

Lim, Jun Wei; Ridley, David; Johnston, Linda R.; Clift, Benedict A.

Published in:
Journal of Arthroplasty

DOI:
[10.1016/j.arth.2017.02.007](https://doi.org/10.1016/j.arth.2017.02.007)

Publication date:
2017

Document Version
Peer reviewed version

[Link to publication in Discovery Research Portal](#)

Citation for published version (APA):

Lim, J. W., Ridley, D., Johnston, L. R., & Clift, B. A. (2017). Acetabulum-Only Revision Total Hip Arthroplasty Is Associated With Good Functional Outcomes and Survivorship. *Journal of Arthroplasty*, 32(7), 2219-2225.e1. <https://doi.org/10.1016/j.arth.2017.02.007>

General rights

Copyright and moral rights for the publications made accessible in Discovery Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from Discovery Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

**ACETABULUM ONLY REVISION HIP ARTHROPLASTY IS ASSOCIATED WITH
GOOD FUNCTIONAL OUTCOMES AND SURVIVORSHIP**

Jun Wei Lim, BMSc MBChB¹

David Ridley, BSc MSc²

Linda R. Johnston, RGN BN MSc²

Benedict A. Clift, BMSc FRCSOrtho¹

1. Department of Orthopaedics and Trauma, Ninewells Hospital and Medical School, DD1 9SY, Dundee, United Kingdom.
2. University of Dundee, Ninewells Hospital and Medical School, DD1 9SY, Dundee, United Kingdom

Please address all correspondence to:

Dr Jun Wei LIM

BMSc (Hons) MBChB

Department of Orthopaedics and Trauma

Ninewells Hospital

DD1 9SY

Dundee, United Kingdom.

Department's Phone Number: 01382 425 576

Department's Fax Number: 01382 496 201

Email: junlim@nhs.net, jun.w.lim@gmail.com

Abstract

Background: The coexistence of a stable femoral and a loose acetabular component may pose a clinical dilemma for the surgeon. Our study aims to compare the intermediate functional outcomes and survivorship of acetabulum only revision THA (ArTHA) with an age and gender matched total revision THA (TrTHA) group.

Methods: We retrospectively reviewed prospectively collected data on the pain, function and total Harris Hip Scores (HHS) and complication profile for ArTHA and TrTHA cohorts from our regional arthroplasty database. Kaplan-Meier survivorship, with the need for repeat revision surgery as the endpoint, was used for survival analysis.

Results: Among 538 cases, there were fewer acute medical complications in ArTHA and a similar dislocation rate for both cohorts. Preoperative HHS for pain, function and total were better in the ArTHA cohort, but only the function score reached statistical significance. No significant differences in subsequent years for all aspects of HHS, except the function score was significantly better in the ArTHA cohort at year 1. 10.0% of ArTHAs and 7.8% of TrTHAs had required rerevision. The 5-year survivorship was 90.3% (95% CI \pm 2.1%) for the ArTHA cohort and 92.7% (95% CI \pm 1.8%) for the TrTHA cohort ($p = 0.394$). The ArTHA with posterior approach ($n=118$) group had the lowest dislocation rate and the best trend of functional outcomes.

Conclusion: ArTHA can provide similar functional outcomes and dislocation rate to TrTHA, with an acceptable rerevision rate. The posterior approach in this study was not associated with a significant dislocation rate.

(247 words)

1 **ACETABULUM ONLY REVISION HIP ARTHROPLASTY IS ASSOCIATED WITH**
2 **GOOD FUNCTIONAL OUTCOMES AND SURVIVORSHIP**

3 *Abstract*

4 Background: The coexistence of a stable femoral and a loose acetabular component may pose a
5 clinical dilemma for the surgeon. Our study aims to compare the intermediate functional
6 outcomes and survivorship of acetabulum only revision THA (ArTHA) with an age and gender
7 matched total revision THA (TrTHA) group.

8
9 Methods: We retrospectively reviewed prospectively collected data on the pain, function and
10 total Harris Hip Scores (HHS) and complication profile for ArTHA and TrTHA cohorts from
11 our regional arthroplasty database. Kaplan-Meier survivorship, with the need for repeat
12 revision surgery as the endpoint, was used for survival analysis.

13
14 Results: Among 538 cases, there were fewer acute medical complications in ArTHA and a
15 similar dislocation rate for both cohorts. Preoperative HHS for pain, function and total were
16 better in the ArTHA cohort, but only the function score reached statistical significance. No
17 significant differences in subsequent years for all aspects of HHS, except the function score
18 was significantly better in the ArTHA cohort at year 1. 10.0% of ArTHAs and 7.8% of
19 TrTHAs had required rerevision. The 5-year survivorship was 90.3% (95% CI \pm 2.1%) for the
20 ArTHA cohort and 92.7% (95% CI \pm 1.8%) for the TrTHA cohort ($p = 0.394$). The ArTHA
21 with posterior approach ($n=118$) group had the lowest dislocation rate and the best trend of
22 functional outcomes.

23

24 Conclusion: ArTHA can provide similar functional outcomes and dislocation rate to TrTHA,
25 with an acceptable rerevision rate. The posterior approach in this study was not associated with
26 a significant dislocation rate.

27 (247 words)

28

29 Keywords: Hip; Revision Arthroplasty; Acetabulum; Functional Outcomes; Survivorship.

30

31

32 *Introduction*

33 During revision hip surgery, the coexistence of a stable with a loose component may pose a
34 clinical dilemma for the surgeon. There is some limited evidence in the literature to suggest
35 that acetabulum only revision total hip arthroplasty (ArTHA) can be technically challenging
36 due to the limited exposure [1]. Furthermore, it has been suggested that ArTHA is associated
37 with a higher instability and dislocation risk due to a potential difficulty in soft tissue
38 balancing [2], and the obvious fact that only one component can be realigned. As the rate and
39 incidence of implant loosening can be variable, some authors further suggested that total
40 revision total hip arthroplasty (TrTHA) with new implants can enhance the longevity of
41 revision total hip arthroplasty (rTHA) in general [3-5].

42

43 Nonetheless, the removal of a well-fixed femoral implant can result in significant damage to
44 the remaining bone stock, more soft tissue trauma and a longer operative time, all of which,
45 when considering the longer term outcomes, are potentially detrimental [5]. In addition,
46 dislocation remains a relatively common and distressing complication following rTHA [6].
47 Many studies have been done to determine the best approach for primary THA to reduce
48 dislocation risk [7, 8]. However, there is no clear consensus with regard to this in rTHA [9,
49 10].

50

51 Based on our experience, we have not agreed with the common belief that ArTHA are
52 associated with less good functional outcome and survivorship. In practice, it is nearly always
53 a well fixed femoral stem with a loose acetabular component. Furthermore, we believe that

54 both anterolateral and posterior approaches have their own merits and limitations; and the
55 approach should be based on patient characteristics, surgeon's experience and surgeon's
56 preference. We therefore conducted this retrospective review of our experience to evaluate the
57 medium term functional outcomes and survivorship of ArTHA in a relatively large cohort with
58 an age and gender matched TrTHA cohort. Our study further determines: 1) the complication
59 profiles and rerevision rate in both cohorts; and 2) the functional outcomes and survivorship of
60 ArTHA and TrTHA with different surgical approaches.

61

62 *Patients and Methods*

63 With Caldicott approval, we reviewed all ArTHA cases with an age and sex matched cohort of
64 TrTHA from a prospective arthroplasty database that registers every patient undergoing joint
65 arthroplasty in our region. The TrTHA cohort was selected from a possible 883 cases where:

- 66 • Age was between the minimum and maximum ages in the ArTHA cohort;
- 67 • Date of operation was between the earliest and latest dates of operation in the ArTHA
68 cohort; and
- 69 • Surgery was performed at the same hospitals as those in the ArTHA cohort.

70

71 An individual match for each ArTHA case was randomly selected from a subset of TrTHA
72 cases of the same gender, age and year of operation. Where none existed, age matching was
73 relaxed in increments of 1 year either way, to a maximum of 3 years until a match was found.
74 When more than one possible match existed, the TrTHA case was randomly chosen. If they
75 remained unmatched, the ArTHA cases were excluded.

76

77 The functional outcomes for rTHA were based on Harris Hip Score (HHS) according to pain,
78 function and the total score (Appendix 1). The reason for rTHA, the preoperative HHS and at
79 years 1, 3 and 5 across both cohorts were identified and compared. In addition, the functional
80 outcomes between the ArTHA and TrTHA cohorts with different surgical approaches were
81 further analysed. Our grouping cohorts were: acetabulum-only revision total hip arthroplasty
82 with anterolateral approach [ArTHA (AL)], acetabulum-only revision total hip arthroplasty
83 with posterior approach [ArTHA (P)], total revision total hip arthroplasty with anterolateral
84 approach [TrTHA (AL)] and total revision total hip arthroplasty with posterior approach
85 [TrTHA (P)]. Subsequently, the rerevision rate and indication for rerevision were compared
86 between the study cohorts.

87

88 The Charnley Classification was used to assess patient's comorbidities where:

- 89 • A - 1 hip affected;
- 90 • B - both hips affected;
- 91 • C - multiple joint disease or other disabilities leading to difficulties in walking [11].

92 Medical and surgical complications were compared. Chest pain, myocardial infarction and
93 cardiac arrest were considered as cardiac complications. Gastrointestinal bleeding was
94 classified as a gastrointestinal complication. Urinary tract infection and acute kidney injury
95 were classified as renal complications. Chest infection was classified as a respiratory
96 complication. Wound complications included delayed wound healing, wound dehiscence,
97 excessive bleeding, blistering and excessive bruising. For infection complications, we only

98 considered positive laboratory culture and reported superficial and deep infection during
99 hospital stay. Reported nerve deficit and ankle dorsiflexion weakness were considered as nerve
100 injury complications. Patients with more than one complication reported were placed into '>1
101 complications' category. For surgical complications, we specifically recorded the incidence of
102 acute dislocation and acute periprosthetic fracture.

103

104 Statistical analysis was performed using Statistical Package for the Social Sciences software
105 (SPSS for Microsoft, Version 21.0). The mean, range and percentage were used for descriptive
106 statistics. The Shapiro-Wilk test was used to test data normality and the Mann-Whitney test
107 was used to assess the statistical significance between ArTHA and TrTHA cohorts. The
108 Kruskal Wallis test was used to assess the statistical significance between both cohorts with
109 different surgical approaches. The Kaplan-Meier survivorship, with the need for rerevision
110 surgery as the endpoint, was used for survival analysis. Censored observations, such as patients
111 who died and those who were lost to follow-up were included in the survivorship analysis. The
112 survivorship analysis was based on the assumption that not all implants will be revised and
113 even if the exact time of rerevision for censored observations was not known, the implant was
114 at least known to be unrevised before being censored [12]. The log-rank test was used to
115 identify significant differences between the survival curves of the study cohorts. A p-value less
116 than 0.05 were regarded as statistically significant.

117

118 **Results**

119 There were 355 ArTHA cases in the regional database, from year 1993 to 2014. 39 unmatched
120 cases, 12 hip resurfacing cases and 1 deceased case with insufficient detail were excluded. We

121 compared a total of 269 ArTHA cases to a randomised age and gender matched TrTHA cohort.
122 Among the 538 cases, we had a rate of loss of 29.7% (160 out of 538) with a 68.1% (109 out
123 of 160) death rate within these lost cases, from an unrelated event. The rate of loss was similar
124 across both ArTHA and TrTHA cohorts (29.4% vs 30.1%). We have assumed that the causes
125 of loss to follow up other than death itself, were similar in the two cohorts.

126

127 Patient demographics are shown in Table 1. The majority of patients fell into Charnley Class C
128 for both ArTHA and TrTHA cohorts. The BMI and survival years did not differ significantly
129 for both cohorts ($p = 0.468$; 0.942). The length of hospital stay for the ArTHA cohort was
130 significantly shorter than for the TrTHA cohort (9 days vs 12 days; $p = 0.001$). At year 1, our
131 institute achieved patient satisfaction rates of 93.4% (184 out of 197) and 95.9% (188 out of
132 196) for ArTHA and TrTHA cohorts respectively. At year 5, our institute again achieved
133 comparative patient satisfaction rates for both ArTHA and TrTHA cohorts [93.5% (87 out of
134 93) vs 92.8% (90 out of 97)]. The most common indication for performing rTHA for both
135 cohorts was aseptic loosening, followed by dislocation for ArTHA and infection for the
136 TrTHA cohort (Table 2).

137

138 The comparison of HHS for pain, function and total score are shown in Figure 1 (a, b and c).
139 The preoperative HHS for pain, function and total were better in the ArTHA cohort, but only
140 the function score reached statistical significance [(function score, $p = 0.020$); (pain and total
141 score, $p = 0.154$; 0.053)]. Furthermore, there were no significant differences in subsequent
142 years for all aspects of HHS, except the function score was significantly better in the ArTHA
143 cohort at year 1 ($p = 0.045$). Further analysis revealed that the TrTHA cohort had a higher

144 score improvement at year 1 than the ArTHA cohort in all 3 aspects of HHS, but only HHS for
145 pain reached statistical significance ($p = 0.021$) (Table 3).

146

147 During our study period, we had 149 ArTHA (AL), 118 ArTHA (P), 130 TrTHA (AL) and 135
148 TrTHA (P) cases. 6 cases were excluded as no surgical approaches were recorded. The
149 comparison of all 3 aspects of HHS for the surgical approaches are shown in Figure 2 (a, b and
150 c). ArTHA (P) group was associated with the best preoperative HHS and performed best in the
151 subsequent years for function and total HHS. However, none of the recorded parameters at any
152 point of this study, including preoperative, postoperative and score improvement at 1 year
153 reached statistical significance.

154

155 There were no intraoperative deaths in our study cohorts. With regard to surgical
156 complications, our study had an acute periprosthetic fracture rate of 0.74% (2 out of 269) in the
157 ArTHA cohort and 7.43% (20 out of 269) in the TrTHA cohort. However, we were unable to
158 identify if they were acetabular or femoral fractures, due to insufficient detail in the database.
159 The dislocation rates were similar in both ArTHA and TrTHA cohorts (6.0% vs 5.6%).
160 However, the dislocation rate was the lowest for the ArTHA (P) group, followed by TrTHA
161 (P), TrTHA (AL) then ArTHA (AL) group (3.4%; 4.4%; 6.9% and 8.1%). The ArTHA cohort
162 was associated with fewer medical complications than the TrTHA cohort (4.1% vs 12.6%).
163 Wound infection was the most common postoperative medical complication in our study
164 cohorts (Table 4).

165

166 In our study, 27 (10.0%) of ArTHAs and 21 (7.8%) of TrTHAs had required rerevision. The 5-
167 year survivorship was 90.3% (95% CI \pm 2.1%) for the ArTHA cohort and 92.7% (95% CI \pm
168 1.8%) for the TrTHA cohort. There was no statistical difference between ArTHA and TrTHA
169 cohorts in the Kaplan-Meier survivorship analysis ($p = 0.394$) (Figure 3). The ArTHA (AL)
170 group appeared to have the shortest 5-year Kaplan-Meier survivorship of 89.7% (95%
171 CI \pm 2.9%), followed by ArTHA (P) group with survivorship of 90.9% (95% CI \pm 3.0%),
172 TrTHA (AL) with survivorship of 91.4% (95% CI \pm 3.1%) and the TrTHA (P) group with the
173 longest survivorship of 92.4% (95% CI \pm 2.8%); with a non-significant p -value of 0.533
174 (Figure 4). The indications for rerevision were similar to rTHA, with similar rerevision rate
175 due to aseptic loosening in both ArTHA and TrTHA cohorts. Our study had one rerevision due
176 to periprosthetic fracture in the ArTHA cohort (Table 5).

177

178 *Discussion*

179 When presented with one loose component and one stable component, surgeons have the
180 choice of performing a single component or both components revision. ArTHA is indicated for
181 acetabulum component failure when the femoral implant remains well fixed [2, 13]. Our
182 retrospective review has demonstrated that ArTHA can provide similar functional outcome,
183 dislocation rate and acceptable revision rate as TrTHA, with the addition of fewer
184 postoperative medical complications.

185

186 It is well known that rTHA is commonly associated with a higher complication rate, associated
187 with more extensive blood loss and a longer operative time, than primary THA [4, 14].
188 Surgeons are generally more cautious when selecting patients for rTHA as patients are older
189 and often less healthy than they were at the time of the primary arthroplasty [14]. Increasing
190 age and medical comorbidities are both predictors of major postoperative complications

191 following rTHA [14]. Despite that, Parvizi *et al.* demonstrated that rTHA can provide
192 substantial clinical benefits to octogenarians and the prevalence of medical complications did
193 not appear to differ significantly when compared to younger patients [15]. Our study had a
194 mean age of 72 ± 9 years, which was slightly older than in most studies [16-19] and most of
195 our patients fell into Charnley Class C. Despite that, our medical complication rates for both
196 ArTHA and TrTHA cohorts were still generally lower than in the literature [14].

197

198 Traditionally, rTHA is thought to be associated with lower patient satisfaction and less
199 functional improvement than primary THA [20]. Eisler *et al.* further reported that patients
200 actually have high expectations regarding rTHA: 92% of 66 consecutive rTHA patients
201 expected to have much less pain and 82% of them expected the same walking ability as with
202 primary THA, following rTHA [21]. Philpott *et al.* performed a retrospective observational
203 study on rTHA patients with a minimum 10 years follow up and demonstrated a patient
204 satisfaction rate of 92% post rTHA [22]. Similarly, our institute was able to achieve
205 comparable satisfaction rates to the literature for both cohorts.

206

207 With regard to functional improvement, Cho *et al.* demonstrated an improvement of 33.4
208 points on the average HHS at 9.2 years follow up, on 29 isolated acetabulum revisions [3]. Our
209 study had a lower improvement in HHS than the literature. This was possibly due to a lower
210 preoperative HHS for both cohorts than in the literature. Therefore, the results were not likely
211 to be limited by retention of the femoral component. Despite that, our study still demonstrated
212 an overall high level of patient satisfaction following rTHA in both cohorts.

213

214 rTHA is known to be associated with a higher dislocation risk and periprosthetic fracture risk
215 than primary THA. One large prospective cohort study on rTHA reported a periprosthetic

216 fracture rate of 4% from day 1 to 30 post-operatively [23]. We were unable to determine if our
217 ‘acute periprosthetic fracture’ occurred intraoperatively or postoperatively within the hospital
218 stay due to insufficient detail in the documentation. However, our periprosthetic fracture rates
219 were within the range reported in previous intraoperative series, with a lower rate in the
220 ArTHA cohort [23, 24]. Some studies reported a higher dislocation rate (8% to 25%) after
221 ArTHA than after TrTHA [4, 25, 26], which was not observed in our study.

222

223 There is no agreement on the optimal exposure during rTHA [3]. Several patient and surgical
224 factors have been proposed that might influence the risk of dislocation following rTHA [6, 27,
225 28]. Alberton *et al.* reported a dislocation rate of 7.4% following rTHA. They suggested that
226 there was no significant association between surgical approach and dislocation rate. The
227 authors further concluded that the extent of soft tissue dissection plays the main role in hip
228 stability after rTHA [28]. Furthermore, surgical approach can be one of the risk factors for cup
229 malpositioning and have tremendous effect on the implant stability [29, 30]. There is a fear of
230 dislocation with the posterior approach, which this study addresses. However, generally
231 speaking, the posterior approach provides the best visualisation of the acetabulum, particularly
232 in cases with extensive bone loss. Posterior capsulotomies can often be managed by increasing
233 the acetabular anteversion and the performance of a robust soft tissue repair. In rTHA, it can be
234 difficult to locate the short external rotators and capsule with a previous posterior approach.
235 Commonly, the posterior soft tissue is attached to the posterior border of the greater trochanter
236 as a single layer without distinguishing the capsule from the short external rotators. In some
237 cases, posterior soft tissue repair is impossible due to increased offset for stability [9]. Suh *et*
238 *al.* demonstrated a markedly decreased dislocation rate after posterior capsule and short
239 external rotators repair [9]. In many cases, the fibrous scar tissue actually provides excellent
240 purchase for surgical sutures. It has been reported that ArTHA via the posterior approach has

241 been associated with one of the highest overall rates of dislocation [25], which is not consistent
242 with our study where our ArTHA via posterior approach group achieved the best functional
243 outcome and lowest dislocation rate. In this study, surgical approach was decided by the
244 individual surgeon's preference. There were undoubtedly many cases of using a posterior
245 approach for a revision after an anterolateral approach for a primary. There will have been
246 some cases where the converse applied, but the database did not contain the detail to comment
247 upon this further.

248

249 Extensive literature searches revealed three published papers to have greater than 1000 rTHA
250 cases with overall survivorship of 82% at 10 years [22, 31]. The implant survival in the
251 literature varied, depending on the indication for revision surgery, the cohort size and follow
252 up time [22, 31]. The performance for both of our cohorts in the 5-year Kaplan-Meier
253 cumulative survival analysis was not significantly different. We cannot find any evidence to
254 suggest that the statistically non-significant but slightly lower survivorship for the ArTHA
255 cohort was due to the preservation of the original femoral component. Importantly, we were
256 able to achieve a lower dislocation rate, a lower periprosthetic fracture rate and an acceptable
257 rerevision rate and survivorship in both cohorts, compared to other studies [22, 31].

258

259 To our knowledge, this is the first large age and gender matched comparative study of ArTHA
260 and TrTHA cohorts. We acknowledge that the current study has certain limitations. The
261 reduced cohort sizes when adding in the factor of surgical approach means that any conclusion
262 about implant survivorship for each surgical approach needs to be interpreted with caution.
263 Albeit not statistically significant, our results indicated a trend of best functional outcomes
264 with ArTHA (P) but slightly lower survivorship than both TrTHA approach groups by a very
265 small margin. This may be important for the surgeon when making decisions about rTHA,

266 particularly in young patients. Further investigation regarding the best surgical approach is still
267 warranted, but our study does provide a realistic outcome prediction for both surgeons and
268 patients regarding the longevity of the prosthesis and also the quality of life after rTHA. The
269 issue of patients lost to follow up is common in studies of this kind. We do not have
270 information on these patients other than those who had died, where that fact is straightforward
271 to determine with current National Health Service (NHS) record keeping. However, we do not
272 consider that this is critical in the study, given that the proportion is roughly the same in both
273 cohorts.

274

275 The documentation on our prospectively collected database is necessarily limited, and in
276 certain areas such as the issue of periprosthetic fractures, there is little detail available.
277 Recourse to the clinical notes has not been possible in many cases, as a significant number of
278 these records are no longer available. This same limitation also applies to the issue over what
279 was the condition of the femoral component in the two main cohorts. The policy in our unit,
280 with all the surgeons, has been only to revise the components which seemed loose or, rarely,
281 problematic in some other way, such as component version. This was determined by
282 preoperative assessment and imaging, and also by the surgeon's intraoperative judgement. We
283 believe that this reflects most surgeons' practice. In essence, very few stable implants were
284 revised, the main exception being those few well fixed acetabular components in the TrTHA
285 group which had significant polyethylene wear.

286

287 We did not find evidence of the femoral component frequently needing to be revised after
288 ArTHA within the time period of the study. The argument is still occasionally advanced when
289 considering rTHA that a 'fresh start' is best by revising both components, even if only one is
290 loose. On the other hand, Moskal *et al.* concluded that ArTHA does not adversely affect both

291 the acetabulum exposure and the stability of acetabulum component [32]. Stathopoulos *et al.*
292 further revealed a similar rerevision rate for ArTHA and TrTHA (21% vs 22%), suggesting
293 that it is not justifiable to revise a stable component [4]. In our practice, if there was a well
294 fixed monobloc stem such as a Charnley in ArTHA, we would ordinarily accept any minor
295 scratches on the femoral head, rather than embark on a full femoral revision. If there was a
296 modular head then we would change that to a new one, which also improved access. The rise
297 of cement within cement revision may reduce the operative morbidity from cement removal
298 [33] but this was not a significant feature of our practice at the time of this study.

299

300 Controversy continues to exist regarding the best fixation method in THA and its subsequent
301 revision risk [34-36]. The most common cause of revision and rerevision were aseptic
302 loosening in both cohorts, which is consistent with the literature [4, 18]. The Norwegian
303 Arthroplasty Register demonstrated a rerevision rate of 6% (165 out of 2751) for ArTHA [17]
304 whereas another study on 27 unrevised femoral components demonstrated a failure rate of 22%
305 with ArTHA [4]. Our rerevision rate for ArTHA cohort (10.0%) was within this reported
306 range. However, our study has limitations in assessing the effectiveness of implant design,
307 fixation method and bearing surfaces on the implant's longevity and its effect on aseptic
308 loosening. Firstly, despite being a relatively large comparative study, further subdividing the
309 study cohort into cemented/ uncemented fixation would reduce the cohort size further and
310 resulted in a bias conclusion. Secondly, large register based observational studies as well as
311 systemic reviews and well conducted prospective randomised trial are better research
312 methodology in assessing the survival of THA [34]. The aim of our study is not to determine
313 which primary implant or fixation method is the most ideal, but to answer the relevant practical
314 question of what can one do when present with a stable femoral and a loose acetabular
315 component.

316

317 In conclusion, our study further confirms the clinical justification for performing ArTHA when
318 clinically indicated. ArTHA can provide similar functional outcome, dislocation rate and
319 acceptable rerevision rate as TrTHA, with addition of fewer postoperative medical
320 complications. Further study regarding surgical approaches is still warranted, but there was no
321 evidence in this study to suggest that the posterior approach had a higher dislocation rate, and
322 it can be safely used in either ArTHA or TrTHA without an increased risk of instability, and
323 potentially with superior acetabular visualisation.

324

(3576 words)

325

327 **References**

- 328 [1] de Thomasson E, Conso C, Mazel C. A well-fixed femoral stem facing a failed
329 acetabular component: to exchange or not? A 5- to 15-year follow-up study. *Orthop*
330 *Traumatol Surg Res* 2012; 98(1):24-29.
- 331 [2] Berry DJ, Trousdale RT, Dennis DA, Paprosky WG. Revision Total Hip and Knee
332 Arthroplasty. Lippincott Williams & Wilkins; 2012. p. 65-74.
- 333 [3] Cho HJ, Han SB, Park JH, Park SW. An analysis of stably fixed femoral components
334 retained during revision total hip arthroplasty. *J Arthroplasty* 2011; 26(8):1239-1244.
- 335 [4] Stathopoulos IP, Lampropoulou-Adamidou KI, Vlamis JA, Georgiades GP,
336 Hartofilakidis GC. One-Component Revision in Total Hip Arthroplasty: The Fate of the
337 Retained Component. *J Arthroplasty* 2014; 29(10):2007-2012.
- 338 [5] Poon ED, Lachiewicz PF. Results of isolated acetabular revisions: the fate of the
339 unrevised femoral component. *J Arthroplasty* 1998; 13(1):42-49.
- 340 [6] Wetters NG, Murray TG, Moric M, Sporer SM, Paprosky WG, Della Valle CJ. Risk
341 factors for dislocation after revision total hip arthroplasty. *Clin Orthop Relat Res* 2013;
342 471(2):410-416.
- 343 [7] Palan J, Beard DJ, Murray DW, Andrew JG, Nolan J. Which approach for total hip
344 arthroplasty: anterolateral or posterior? *Clin Orthop Relat Res* 2009; 467(2):473-477.
- 345 [8] Hailer NP, Weiss RJ, Stark A, Karrholm J. The risk of revision due to dislocation
346 after total hip arthroplasty depends on surgical approach, femoral head size, sex, and primary
347 diagnosis. An analysis of 78,098 operations in the Swedish Hip Arthroplasty Register. *Acta*
348 *Orthop* 2012; 83(5):442-448.
- 349 [9] Suh KT, Roh HL, Moon KP, Shin JK, Lee JS. Posterior Approach With Posterior Soft
350 Tissue Repair in Revision Total Hip Arthroplasty. *J Arthroplasty* 2008; 23(8):1197-1203.

- 351 [10] Mast NH, Laude F. Revision total hip arthroplasty performed through the Hueter
352 interval. *J Bone Joint Surg Am* 2011; 93 Suppl 2:143-148.
- 353 [11] Bjorgul K, Novicoff WM, Saleh KJ. Evaluating comorbidities in total hip and knee
354 arthroplasty: available instruments. *J Orthop Traumatol* 2010; 11(4):203-209.
- 355 [12] Ranstam J, Kärrholm J, Pulkkinen P, Mäkelä K, Espehaug B, Pedersen AB, et al.
356 Statistical analysis of arthroplasty data: I. Introduction and background. *Acta Orthopaedica*
357 2011; 82(3):253-257.
- 358 [13] Taylor ED, Browne JA. Reconstruction options for acetabular revision. *World J*
359 *Orthop* 2012; 3(7):95-100.
- 360 [14] Koenig K, Huddleston Iii JI, Huddleston H, Maloney WJ, Goodman SB. Advanced
361 Age and Comorbidity Increase the Risk for Adverse Events After Revision Total Hip
362 Arthroplasty. *J Arthroplasty* 2012; 27(7):1402-1407.e1401.
- 363 [15] Parvizi J, Pour AE, Keshavarzi NR, D'Apuzzo M, Sharkey PF, Hozack WJ. Revision
364 total hip arthroplasty in octogenarians. A case-control study. *J Bone Joint Surg Am* 2007;
365 89(12):2612-2618.
- 366 [16] Biring GS, Masri BA, Greidanus NV, Duncan CP, Garbuz DS. Predictors of quality
367 of life outcomes after revision total hip replacement. *J Bone Joint Surg Br* 2007;
368 89(11):1446-1451.
- 369 [17] Lie SA, Havelin LI, Furnes ON, Engesaeter LB, Vollset SE. Failure rates for 4762
370 revision total hip arthroplasties in the Norwegian Arthroplasty Register. *J Bone Joint Surg Br*
371 2004; 86(4):504-509.
- 372 [18] Trumm BN, Callaghan JJ, George CA, Liu SS, Goetz DD, Johnston RC. Minimum
373 20-Year Follow-Up Results of Revision Total Hip Arthroplasty With Improved Cementing
374 Technique. *J Arthroplasty* 2014; 29(1):236-241.

- 375 [19] Davis AM, Agnidis Z, Badley E, Kiss A, Waddell JP, Gross AE. Predictors of
376 functional outcome two years following revision hip arthroplasty. *J Bone Joint Surg Am*
377 2006; 88(4):685-691.
- 378 [20] Jibodh SR, Kandil AO, Malchau H, Estok Ii DM. Do Commonly Reported Outcome
379 Measures Reflect Patient Satisfaction After Revision Hip Arthroplasty? *J Arthroplasty* 2010;
380 25(1):41-45.
- 381 [21] Eisler T, Svensson O, Tengström A, Elmstedt E. Patient expectation and satisfaction
382 in revision total hip arthroplasty. *J Arthroplasty* 2002; 17(4):457-462.
- 383 [22] Philpott A, Weston-Simons JS, Grammatopoulos G, Bejon P, Gill HS, McLardy-
384 Smith P, et al. Predictive outcomes of revision total hip replacement—A consecutive series of
385 1176 patients with a minimum 10-year follow-up. *Maturitas* 2014; 77(2):185-190.
- 386 [23] Singh JA, Jensen MR, Lewallen DG. Patient Factors Predict Periprosthetic Fractures
387 After Revision Total Hip Arthroplasty. *The Journal of Arthroplasty* 2012; 27(8):1507-1512.
- 388 [24] So K, Kuroda Y, Matsuda S, Akiyama H. Revision total hip replacement with a
389 cemented long femoral component: minimum 9-year follow-up results. *Arch Orthop Trauma*
390 *Surg* 2013; 133(6):869-874.
- 391 [25] Manning DW, Ponce BA, Chiang PP, Harris WH, Burke DW. Isolated Acetabular
392 Revision Through the Posterior Approach: Short-term Results after Revision of a Recalled
393 Acetabular Component. *The Journal of Arthroplasty* 2005; 20(6):723-729.
- 394 [26] Ito H, Matsuno T, Aoki Y, Minami A. Acetabular components without bulk bone
395 graft in revision surgery:: A 5- to 13-year follow-up study. *J Arthroplasty* 2003; 18(2):134-
396 139.
- 397 [27] Carter AH, Sheehan EC, Mortazavi SM, Purtill JJ, Sharkey PF, Parvizi J. Revision for
398 recurrent instability: what are the predictors of failure? *J Arthroplasty* 2011; 26(6 Suppl):46-
399 52.

- 400 [28] Alberton GM, High WA, Morrey BF. Dislocation After Revision Total Hip
401 Arthroplasty: An Analysis of Risk Factors and Treatment Options. *J Bone Joint Surg Am*
402 2002; 84(10):1788-1792.
- 403 [29] Callanan MC, Jarrett B, Bragdon CR, Zurakowski D, Rubash HE, Freiberg AA, et al.
404 The John Charnley Award: risk factors for cup malpositioning: quality improvement through
405 a joint registry at a tertiary hospital. *Clin Orthop Relat Res* 2011; 469(2):319-329.
- 406 [30] Danoff JR, Bobman JT, Cunn G, Murtaugh T, Gorroochurn P, Geller JA, et al.
407 Redefining the Acetabular Component Safe Zone for Posterior Approach Total Hip
408 Arthroplasty. *J Arthroplasty* 2016; 31(2):506-511.
- 409 [31] Springer BD, Fehring TK, Griffin WL, Odum SM, Masonis JL. Why revision total
410 hip arthroplasty fails. *Clin Orthop Relat Res* 2009; 467(1):166-173.
- 411 [32] Moskal JT, Shen FH, Brown TE. The fate of stable femoral components retained
412 during isolated acetabular revision: a six-to-twelve-year follow-up study. *J Bone Joint Surg*
413 *Am* 2002; 84-a(2):250-255.
- 414 [33] Duncan WW, Hubble MJ, Howell JR, Whitehouse SL, Timperley AJ, Gie GA.
415 Revision of the cemented femoral stem using a cement-in-cement technique: a five- to 15-
416 year review. *J Bone Joint Surg Br* 2009; 91(5):577-582.
- 417 [34] Mäkelä KT, Matilainen M, Pulkkinen P, Fenstad AM, Havelin L, Engesaeter L, et al.
418 Failure rate of cemented and uncemented total hip replacements: register study of combined
419 Nordic database of four nations. *BMJ : British Medical Journal* 2014; 348.
- 420 [35] Wyatt M, Hooper G, Frampton C, Rothwell A. Survival outcomes of cemented
421 compared to uncemented stems in primary total hip replacement. *World Journal of*
422 *Orthopedics* 2014; 5(5):591-596.

423 [36] Abdulkarim A, Ellanti P, Motterlini N, Fahey T, O'Byrne JM. Cemented versus
424 uncemented fixation in total hip replacement: a systematic review and meta-analysis of
425 randomized controlled trials. *Orthopedic Reviews* 2013; 5(1):e8.

426

Figure 1a
[Click here to download Figures \(Number each one\): HHS Pain_1.eps](#)

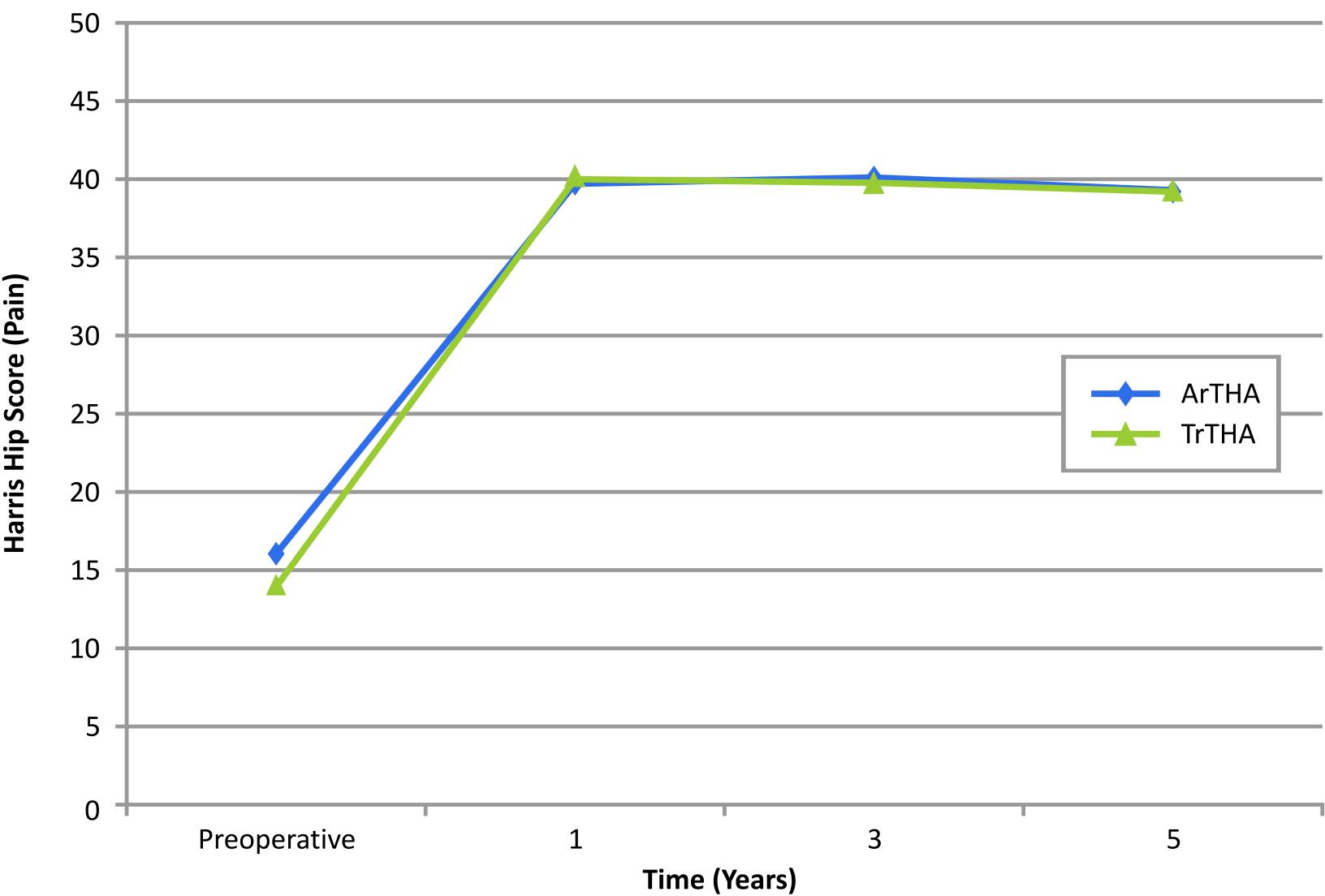


Figure 1b
[Click here to download Figures \(Number each one\): HHS Function_1.eps](#)

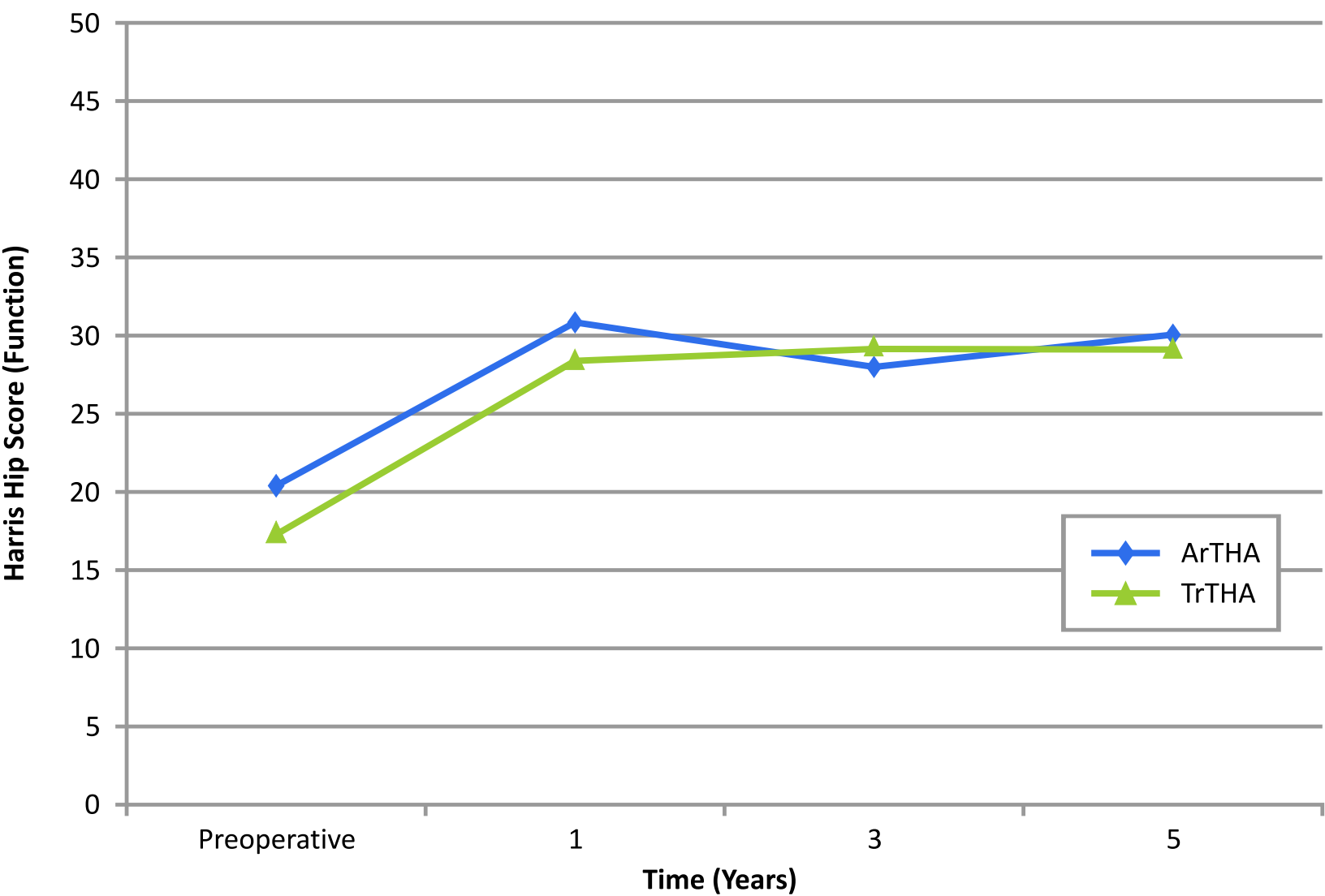


Figure 1c
Click here to download Figures (Number each one): HHS Total_1.eps

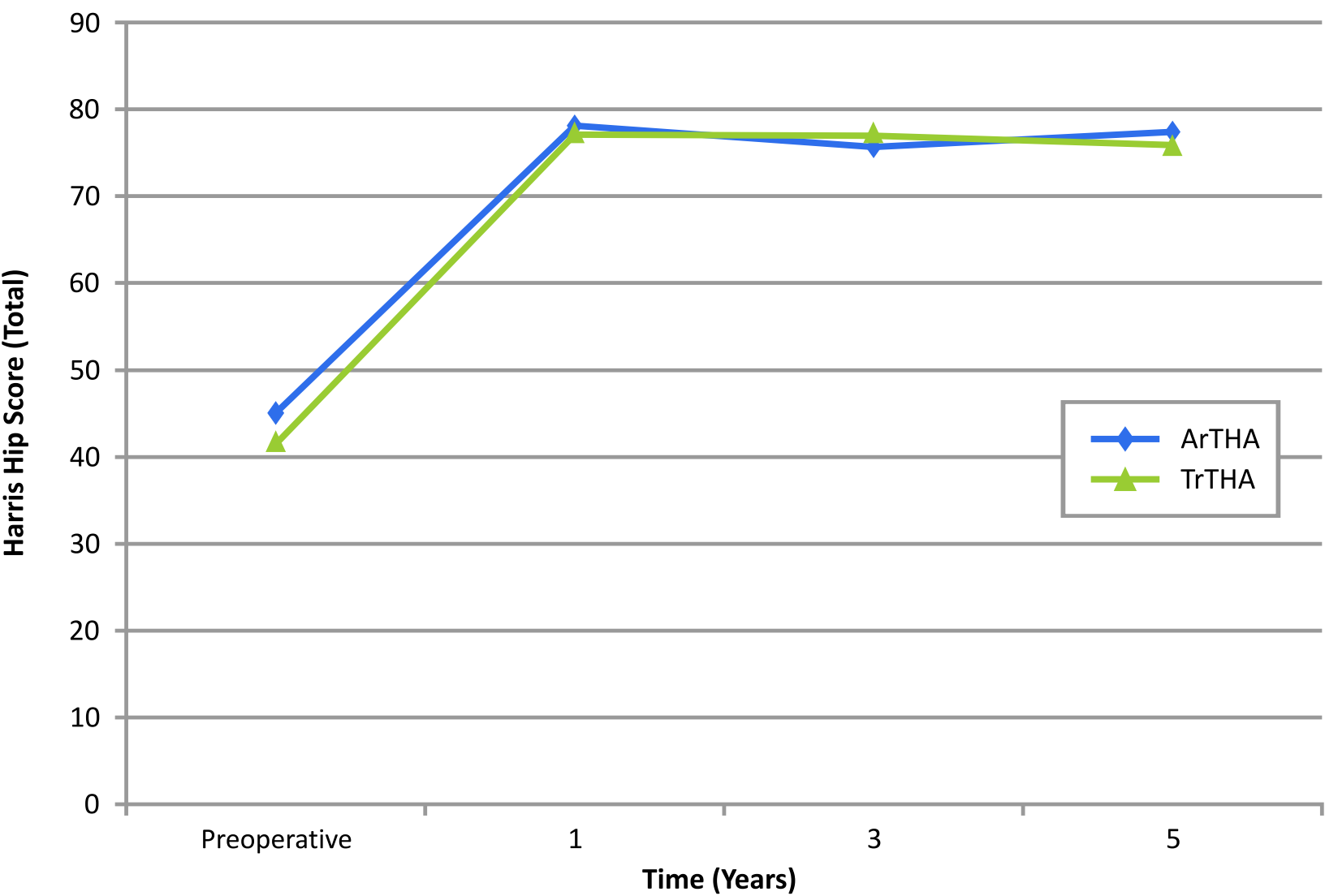


Figure 2a
[Click here to download Figures \(Number each one\): HHS Pain_2.eps](#)

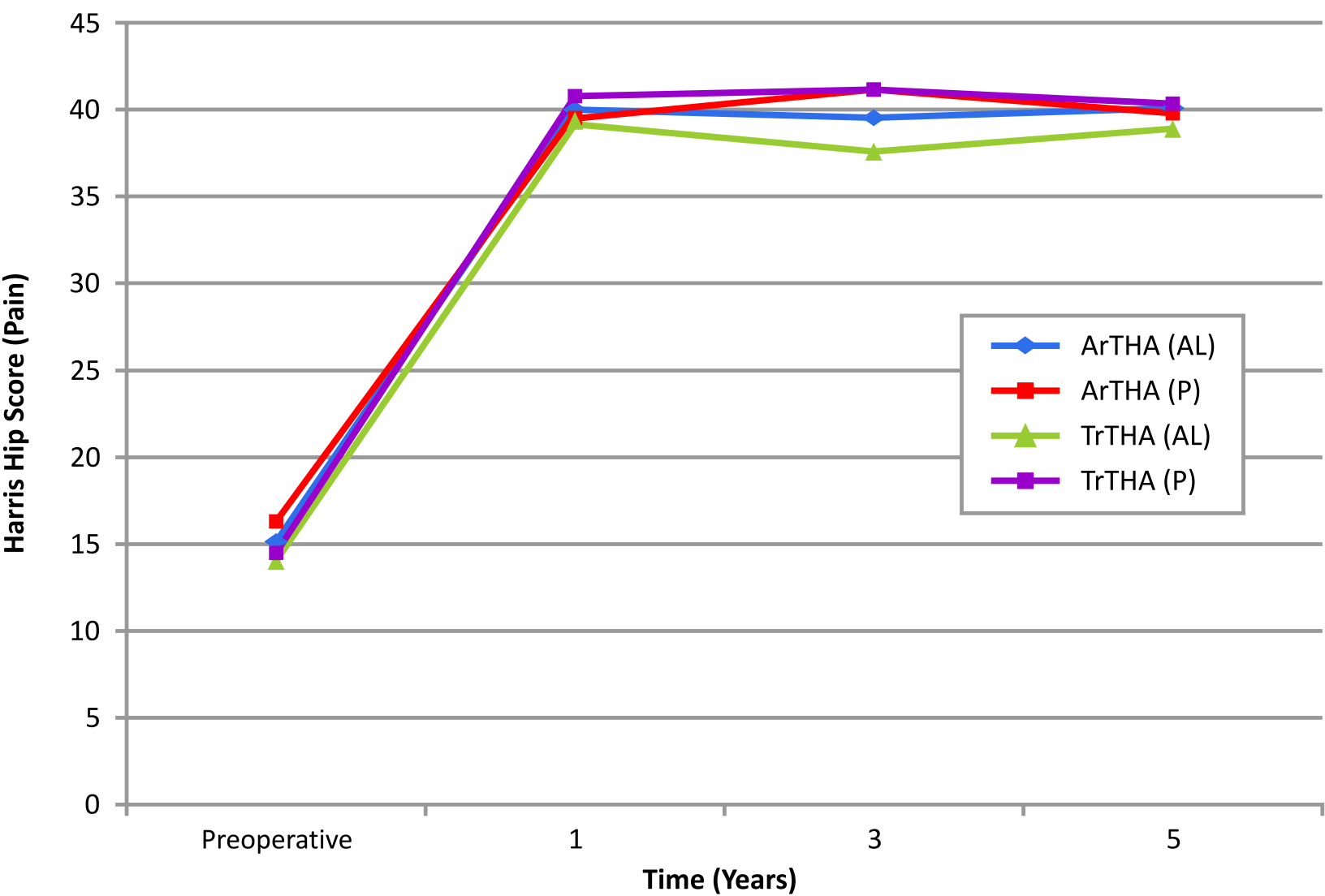


Figure 2b
Click here to download Figures (Number each one): HHS Function_2.eps

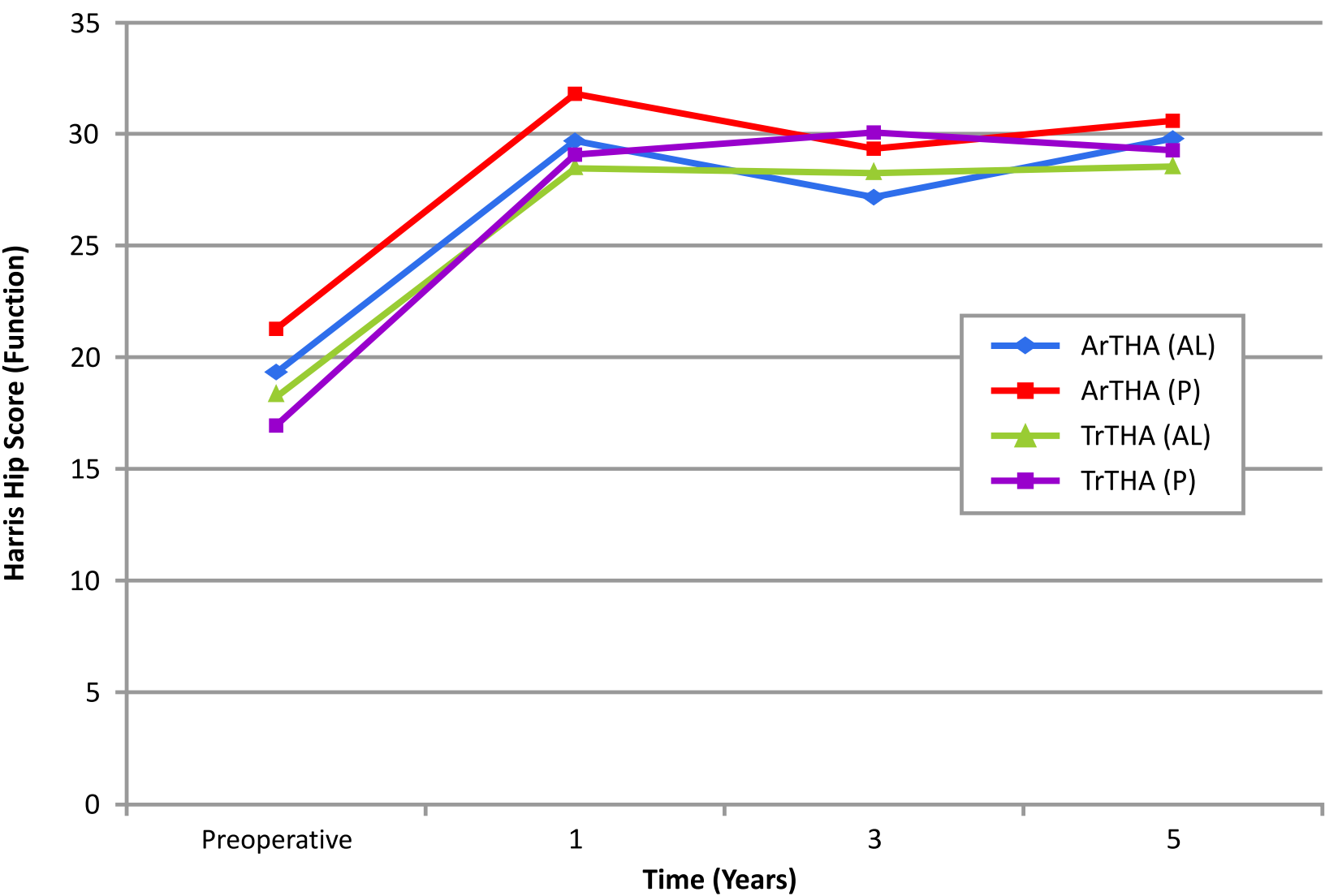


Figure 2c
Click here to download Figures (Number each one): HHS Total_2.eps

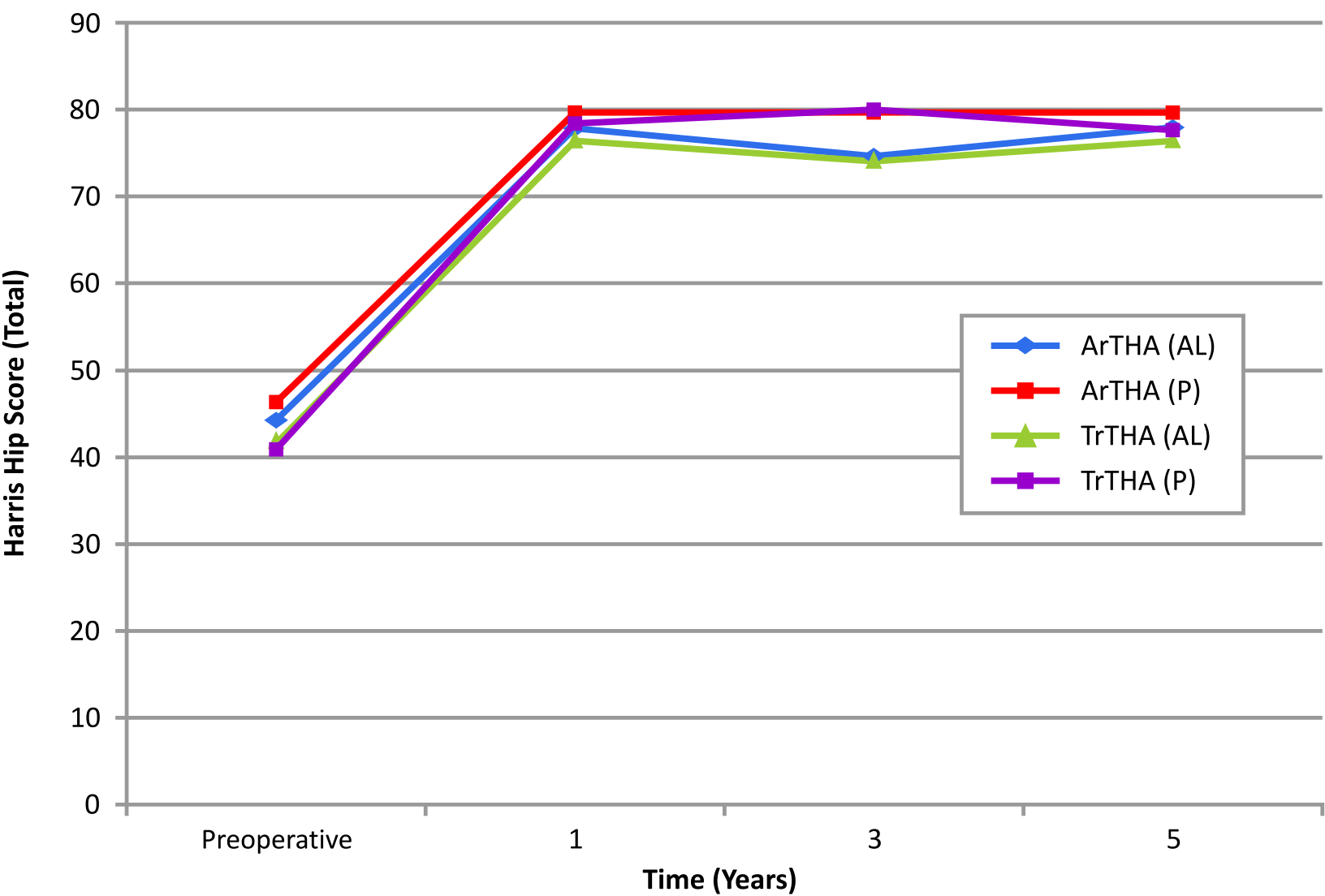


Figure 3

[Click here to download Figures \(Number each one\): Survival Graph_1.eps](#)

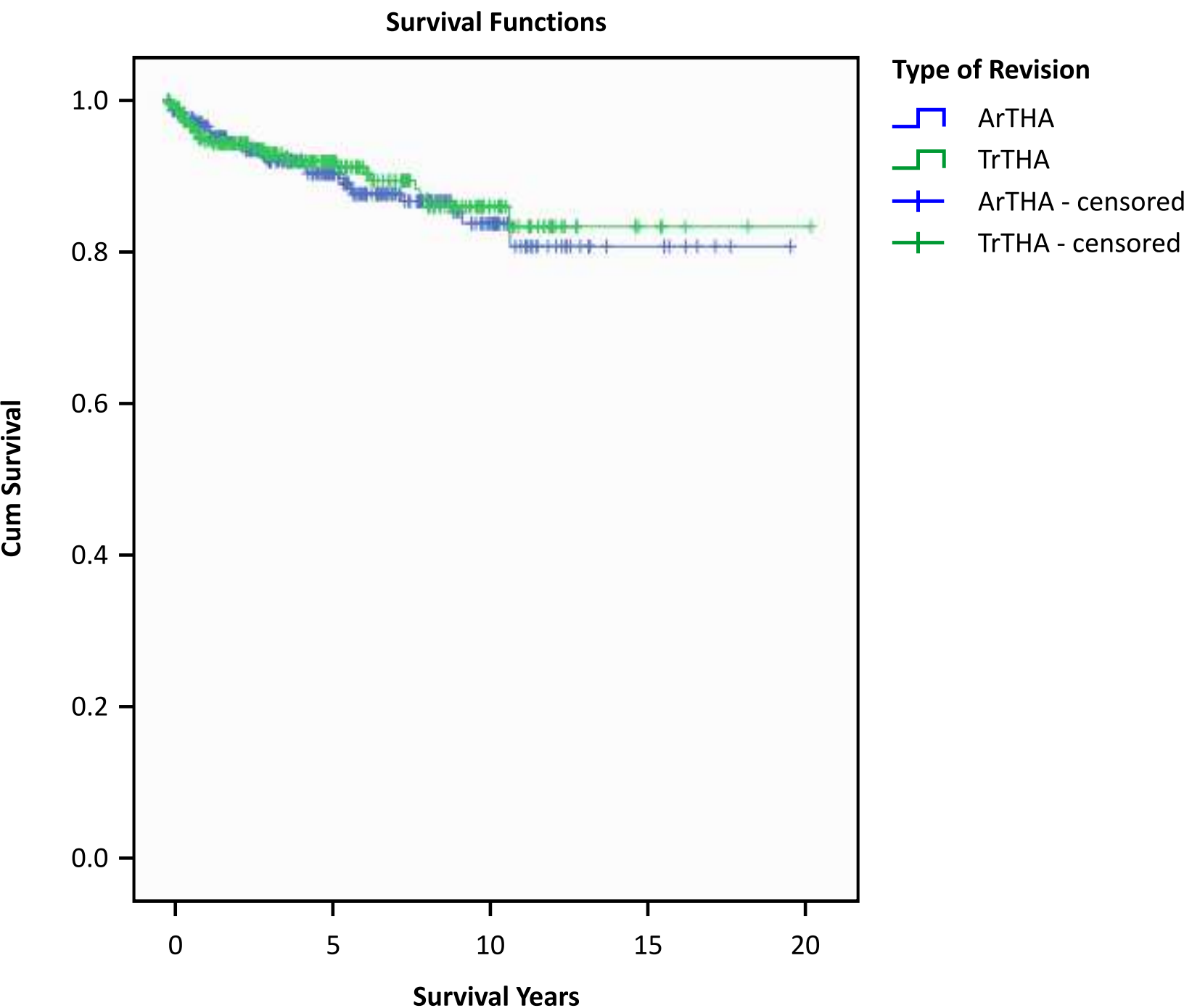


Figure 4

[Click here to download Figures \(Number each one\): Survival Graph_2.eps](#)

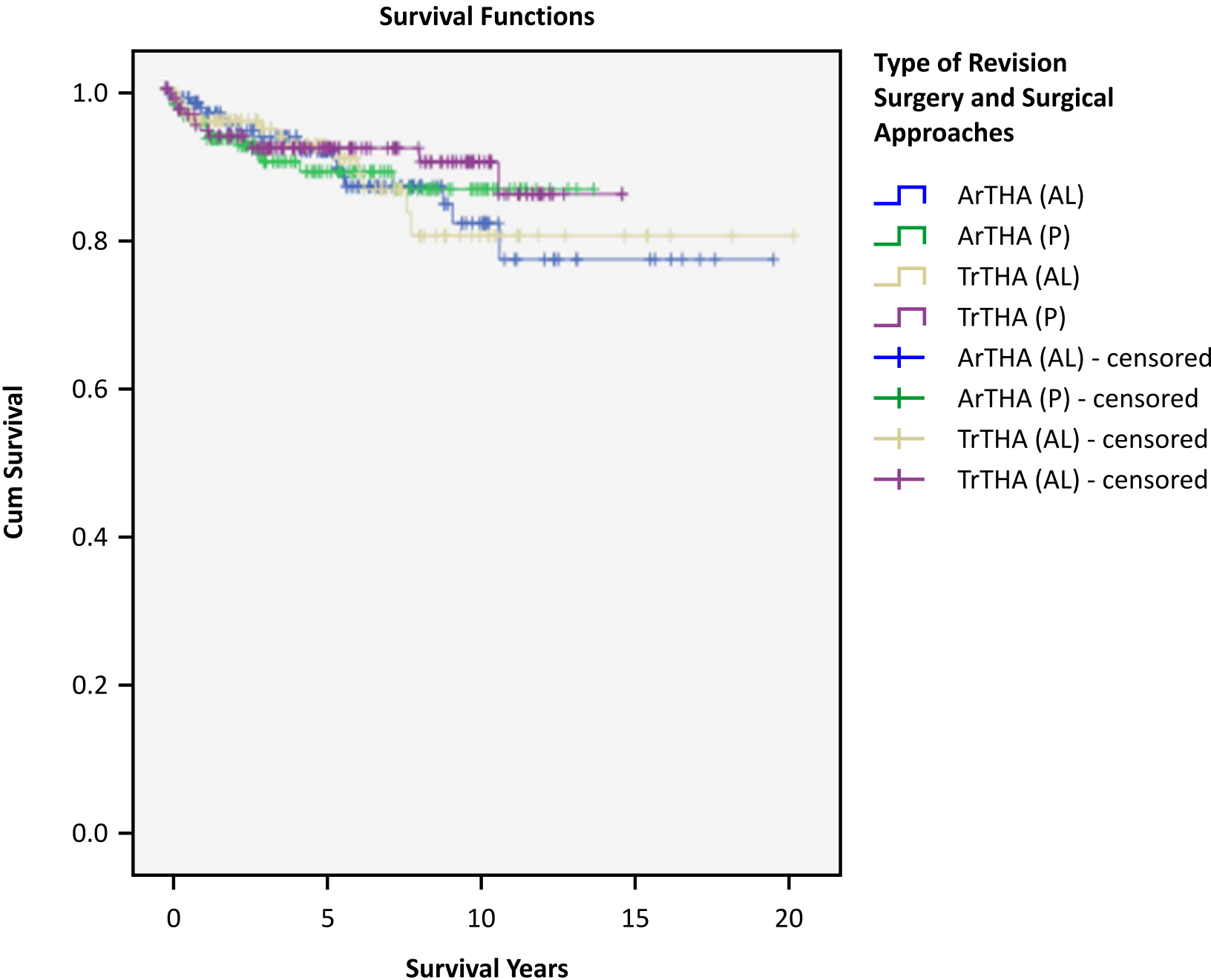


Figure Legends:

Figure 1a: Harris Hip Score (Pain) over 5-year.

Figure 1b: Harris Hip Score (Function) over 5-year.

Figure 1c: Harris Hip Score (Total) over 5-year.

Figure 2a: Harris Hip Score (Pain) over 5-year in different surgical approach groups.

Figure 2b: Harris Hip Score (Function) over 5-year in different surgical approach groups.

Figure 2c: Harris Hip Score (Total) over 5-year in different surgical approach groups.

Figure 3: Kaplan Meir survivorship for ArTHA and TrTHA cohorts.

Figure 4: Kaplan Meir survivorship for different surgical approach groups.

Appendix

Appendix 1: Harris Hip Score.

Category	Harris Hip Score
Excellent	90-100
Good	80-89
Fair	70-79
Poor	<70

Tables

Table 1: Patient demographics.

Variables	ArTHA			TrTHA		
	n	Mean ± STDEV	Range	n	Mean ± STDEV	Range
Gender (F:M)	269	165:104		269	165:104	
Leg (L:R)	269	109:160		269	129:140	
Age	269	72 ± 9	43 to 93	269	72 ± 9	43 to 92
BMI	232	27.4 ± 4.5	17 to 41	223	27.9 ± 5.2	16 to 48
Survival Years	269	5.49 ± 3.86	0.01 to 18.89	269	5.45 ± 3.81	0.05 to 19.51
Hospital Stay	265	9 ± 7	2 to 66	268	12 ± 14	2 to 123
Preoperative Charnley Class	A	54/215		61/227		
	B	21/215		20/227		
	C	140/215		146/227		

Table 2: Indication for rTHA.

Indication for rTHA	ArTHA (%)	TrTHA (%)
Aseptic Loosening	70.9	61.5
Dislocation	20.5	7.4
Fracture	1.2	2.7
Implant Failure	1.2	0.0
Infection	1.2	23.7
Instability	2.4	1.9
Unexplained Pain	2.4	2.3
Others	0.4	0.4

Table 3: The improvement of Harris Hip Scores at year 1.

Score Improvement at Year 1	ArTHA			TrTHA			p-value
	n	Mean \pm STDEV	Range	n	Mean \pm STDEV	Range	
Pain	186	24.14 \pm 11.55	-24 to 44	180	26.41 \pm 11.12	-10 to 44	0.021
Function	172	10.58 \pm 9.36	-10 to 45	169	10.65 \pm 9.73	-13 to 37	0.420
Total	133	34.73 \pm 17.37	-29 to 69	127	36.59 \pm 15.89	-10 to 71	0.154

Table 4: Acute Medical Complications.

Medical Complications	ArTHA	TrTHA
Cardiac	1/11	3/34
Gastrointestinal	0/11	1/34
Infection	5/11	13/34
Nerve Injury	3/11	0/34
Renal	0/11	3/34
Respiratory	1/11	1/34
Wound Complications	1/11	8/34
>1 Complications	0/11	5/34

Table 5: Reasons for re-revision.

Indications	ArTHA	TrTHA
Aseptic Loosening	10/26	11/20
Dislocation	6/26	5/20
Infection	7/26	4/20
Implant Failure	2/26	0/20
Periprosthetic Fracture	1/26	0/20

Acknowledgements

The authors would like to thank the Tayside Arthroplasty Audit Group (TAAG) team who has contributed data to this study. The authors are grateful to Dr Weijie Wang for statistical advice and Mr Ian Christie for illustrations.

Conflict of Interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.