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ORIGINAL ARTICLE

Differences of hemiarthroplasty and total hip replacement in orthogeriatric treated elderly patients: a retrospective analysis of the Registry for Geriatric Trauma DGU®

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Abstract

Purpose Medial femoral neck fractures are typically managed with hemiarthroplasty (HA) or total hip arthroplasty (THA) in elderly patients. There is a debate as to which treatment predominates. The literatures have reported better outcomes for those patients with proximal femur fracture who were treated in an orthogeriatric centres compared to standard orthopaedic hospitals. Therefore, we have analysed the differences of outcome between HA and THA on patients, exclusively treated in orthogeriatric co-management and compared the results with the available literature.

Methods We conducted a retrospective registry analysis of the Registry for Geriatric Trauma DGU®. Between 2016 and 2018, data for 16,236 patients from 78 different hospitals were available: they were analysed univariably, and differences between HA and THA were examined using propensity score matching, according to the American Society of Anesthesiologists (ASA) grade, Identification-of-Seniors-At-Risk (ISAR) Score, anticoagulation level, sex, age, and walking ability prefracture.

Results There were 4,662 patients treated with HA and 892 with THA, meeting inclusion criteria. Patients in the HA group were older (84 years (IQR 80–89) vs. 79 years (IQR 75–83); $p<0.001$), with more severe preexisting conditions, with an ASA grade ≥ 3 in 79% vs. 57% in the THA group ($p<0.001$). After matching, the mortality rate, in-house revision rate, and quality of life (QoL) 7 days postoperatively were not significantly different by group. After 120 days, the HA group presented a lower rate of surgical complications (4% vs. 10%; $p=0.006$), while the THA group had a higher rate of independent walking (18% vs. 28%; $p=0.001$) and a higher QoL, measured by the EQ-5D-3L (0.81 (IQR 0.7–1.0) vs. 0.9 (IQR 0.72–1.0); $p=0.01$).

Conclusions Due to better walking ability and QoL, THA might be the better choice in healthier and more mobile patients, while HA would be better for multimorbid patients to avoid additional complication-associated treatments. Not the age of the patient but the preoperative condition might be important for the choice between THA and HA.

Keywords Hip fracture · Hemiarthroplasty · Total hip arthroplasty · Orthogeriatric co-management · Quality of life

Introduction

Multifactorial circumstances directly influence demographics around the world and are responsible for an increase in fractures of the elderly. Approximately 1.6 million annual incidences of proximal femur fractures occurred in 2000, manifesting the tremendous impact they have in the daily routine of traumatology clinics worldwide [1]. Estimations throughout the last couple of years have shown an increase of such fractures. Back in 1995, approximately 122/100,000 patients have suffered a coxal femur fracture, whilst in 2010, we were already able to observe an increase of such numbers to 157/100,000 [2–4].

The latest assumptions confirm there will not be a decline in these numbers in the next few years. By 2030, epidemiologists expect a prevalence increase of 40% [2]. Newly published literature expects that by 2050, we will see more incidence of over 6 million per year [5].

To achieve the best medical outcome for patients suffering from a medial femoral neck fracture (FNF), surgeons must consider various factors before treating it—given the

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question about which is the best way to treat FNF: hemiarthroplasty (HA) or total hip arthroplasty (THA). An analysis of patient needs, lifestyle, walking ability, and preexisting diseases must be considered prior to surgery. The National Institute of Health and Care Excellence (NICE) in the UK recommends that patients with an American Society of Anesthesiologists (ASA) grade of three or less, who are able to walk independently (or with the help of a cane), and are not cognitively impaired, should be treated with a THA [6]. Several recent studies concluded that THA has an advantage in terms of mobility and quality of life (QoL) [7–10]. However, we will not neglect the fact that THA can contribute to higher risk of hip dislocation (relative risk 1.48) [11].

In addition to the surgical treatment, multiple other factors could influence the outcome after FNF in geriatric patients. This led to the development and establishment of orthogeriatric treatment concepts involving trauma surgeons and geriatricians.

In 2007, the German Trauma Society (DGU) started to establish orthogeriatric centres. Since 2014, an independent audit process certifies those treatment units as Centre for Geriatric Trauma DGU (ATZ-DGU).

Certified centres are obliged to treat the patients in an orthogeriatric co-management and to participate in the Registry for Geriatric Trauma DGU (ATR-DGU) [12, 13]. This led to an increased establishment of an orthogeriatric co-management in Germany, with actually more than 100 certified centres. Similar developments took place in many other countries in Western Europe. Data about the effect of orthogeriatric co-managed care of geriatric trauma patients are now available in increasing numbers and could show that orthogeriatric treatment leads to a better outcome and an improved survival rate in this often-frail collective [14–19].

In contrast to the current available literature, our study focused on the differences in outcome after treatment of FNF with THA or HA in geriatric patients, treated exclusively in an orthogeriatric co-management.

Methods

Data sources

All data were collected by the ATR-DGU. The ATR-DGU was founded in 2016 by DGU. The ATR-DGU gathers information about patients with a coxal femur fracture at the age of 70 years or older. Thus far, about 21,000 acute cases are registered with the ATR from approximately 100 certified geriatric trauma centres in Germany, Switzerland, and Austria. Data are collected in five consecutive phases: admission, preop, surgery, first postop week, and discharge/transfer. Furthermore, an optional follow-up can be scheduled for day 120 postoperatively. On days 7 and 120 postoperatively, health-related QoL is queried with the EQ-5D-3L questionnaire. Participation in the ATR-DGU is an obligation for hospitals successfully certified as an official ATZ-DGU. Approval for scientific data analysis from the ATR-DGU is granted via a peer-review procedure in accordance with publication guidelines of the Committee on Geriatric Trauma Registry of the DGU. This study is in accordance with publication guidelines of the ATR-DGU and registered under the ATR-DGU-ID 2019-007.

Patients

We included all patients who registered with the ATR-DGU from 2016 to 2018. This accounts for a total of 16,236 patients from 78 different hospitals, certified as an ATZ. All patients with different hip injuries other than FNF were excluded. Pathologic fractures of the hip, periprosthetic, and peri-implant hip fractures were also excluded, leaving 5554 patients. This cohort splits into 4,662 patients who were treated with HA and 892 patients with THA. Further, some patients had to be excluded from some analyses, due to missing data. Therefore, each analysis shows the total number of patients who could be included.

Outcomes

Outcome parameters were walking ability 120 days after fracture, surgery-associated complications during hospital admission or within 120 postoperative days, mortality during hospital admission and within 120 postoperative days, and QoL at 7 and 120 postoperative days, measured by the EQ-5D-3L.

Covariates

The following covariates were measured: American Society of Anesthesiologists (ASA) grade (1–5), Identification-of-Seniors-At-Risk (ISAR) Score, anticoagulation, sex, age, time-to-surgery, additional injuries, time-do-death in hospital, and actual period in hospital.

Statistical analysis

We conducted a retrospective analysis with the above data. All calculations were performed via statistics software R v. 3.5.3 (Foundation for Statistical Computing, Vienna, Austria). For descriptive analyses, categorical data were presented as frequencies and compared by the χ^2 test. Continuous variables were expressed by median and interquartile range (IQR) for group comparisons with the Mann–Whitney *U* test or Kruskal–Wallis test, as appropriate.

To verify outcomes of geriatric FNF and find superiority to one of two treatment methods (HA or THA), propensity score matching was done per ASA grade, ISAR Score, anticoagulation, sex, age, and walking ability before fracture. Only data which included all these matching criteria were analysed, resulting in 3372 cases for propensity score matching. Twice as many patients with HA were compared to those with THA [20]. Differences were considered statistically significant when $p < 0.05$.

Ethics

Written patient consent was obtained by participating hospitals. The data from the ATR-DGU received full approval from the Ethics Committee of the medical faculty of the Philipps-University, Marburg, Germany (AZ 46/16).

Results

A total of 5554 patients could be analysed in this study. This cohort was split into two collectives: 1 was treated with HA, with 4662 patients, and the other with THA, 892 patients. From those patients, the optional postoperative follow-up date up to 120 days was available only in 2509 cases, resulting in a lost on follow-up of 54.8%. Distribution between sexes was the same for both collectives, with 70% females. The median patient age in the HA group was 85 (IQR 80–89), whereas those in the THA were younger, with a median age of 79 (IQR 75–83) ($p < 0.001$).

Patients in the HA group were usually less healthy, having an ASA grade of three or more, accounting for 80% vs. 58% in the THA ($p < 0.001$). A similar result was found analysing the ISAR Score, with 85% vs. 58% of patients having a score of 2 or more at admission, representing the need for geriatric treatment ($p < 0.001$). HA was more often done during weekends or nationwide holidays (25% vs. 20%; $p = 0.002$) and during on-duty times (21% vs. 15%; $p < 0.001$). The univariable analysis presented is in Table 1.

In-house mortality was higher in the HA group (6% vs. 3%; $p < 0.001$) and post-surgery walking ability was better in the THA group ($p < 0.001$). Table 2 shows postoperative differences. Analysing optional follow-up 120 days postoperatively, a significantly better independent walking ability was found ($p < 0.001$) with all five dimensions of the EQ-5d-3L better in the THA group ($p < 0.001$). However, the rate of surgery associates complications was significantly higher in the THA group (4% vs. 8%; $p = 0.002$). The incidence of readmission rate was not statistically significant (5% in HA vs. 7% in THA; $p = 0.219$). Table 3 presents the differences 120 days postoperatively.

The percentage distribution of changes in walking ability can be seen in Fig. 1. A distinction was made between degradation, no change, and improvement in walking ability 120 days postoperatively, vs. preinjury status. There was no significant difference between HA and THA groups. To create comparable groups, we performed propensity score matching. No significant differences were seen between groups, according to these criteria, with a total of 1335 patients. Table 4 shows differences of included variables before and after matching.

After matching the two groups, in-house mortality (4% vs. 3%; $p = 0.176$) and mortality rate during 120 days postoperatively (5% vs. 3%; $p = 0.540$), were not statistically different. Independent walking without walking aids was achieved by 18% of the HA and 28% of the THA group 120 days postoperatively ($p = 0.001$). The distinction between degradation, no change, and improvement of walking ability 120 days postoperatively failed to reach significance.

For hospital admission, no difference was seen in the rate of surgery-associated complications (3% vs. 3%; $p = 1$), but 120 days postoperatively, HA patients presented a lower rate than THA patients (4% vs. 10%; $p = 0.006$). The most common treatment for surgery-associated complications was the reduction of the prosthesis after dislocation (0% vs. 35%). Comparing the EQ-5D-3L of both collectives 7 days postoperatively, there was no difference, while QoL 120 days was significantly higher in the THA group (0.81 vs. 0.9; $p = 0.01$). Table 5 shows these results after propensity matching.

Discussion

In this multicentre registry study, we found patients with HA were at significantly less risk of surgery-associated complications within 120 days, while there was a significant difference in walking ability and QoL, in favour of THA. We also show there was no difference in mortality within 120 days after operation. Due to the question about the best procedure to treat FNF in the elderly population, there are many publications on the issue, which leads to a highly ranked meta-analysis of randomised controlled trials (RCTs) [21–23]. Comparing inclusion criteria or the number of the study population in these studies, our collective is unique. Most RCTs included patients younger than 70 years [24–26] or excluded those with dementia or care-dependency [9, 27, 28], and who were also not excluded in our analysis. Our results must be discussed, as we present a comparatively older and less healthy cohort. To our knowledge, no other study examined the outcome of patients after FNF with an ASA Score of 3 or more in 79% of the HA group, and a mean age of 85, respectively, or 58% and 79 years in the THA group [21–23].

As a key parameter in this population, we focused on mortality and complication rate. The overall in-house mortality came to 5% with a mortality rate of 6% for HA and 3% for THA ($p < 0.001$), with 11% vs. 6% ($p = 0.003$) on

Table 1 Differences between the HA and THA groups before propensity score matching

	HA *N* = 4662	THA *N* = 892	*p* value
Time-to-surgery [h], median (IQR)	21 (11.6–33.6)	21.6 (14.3–30.6)	0.142
Surgery during weekends or nationwide holidays			0.002*
No	3501 (75%)	713 (80%)	
Yes	1159 (25%)	179 (20%)	
Surgery during on duty times (16:30–07:00)			< 0.001*
No	3538 (79%)	719 (85%)	
Yes	916 (21%)	126 (15%)	
Time-to-surgery			0.01*
< 12 h	1186 (26%)	186 (21%)	
12–24 h	1675 (36%)	358 (40%)	
24–36 h	715 (15%)	149 (17%)	
36–48 h	487 (11%)	100 (11%)	
> 48 h	564 (12%)	92 (10%)	
ASA grade			< 0.001*
1	53 (1%)	27 (3%)	
2	876 (19%)	338 (38%)	
3	3270 (71%)	471 (53%)	
4	400 (9%)	48 (5%)	
5	4 (0%)	0 (0%)	
ISAR Score			< 0.001*
0	187 (6%)	123 (21%)	
1	307 (10%)	123 (21%)	
2	685 (21%)	121 (21%)	
3	802 (25%)	108 (18%)	
4	750 (24%)	77 (13%)	
5	350 (11%)	30 (5%)	
6	110 (3%)	3 (1%)	
Sex			0.816
Male	1408 (30%)	266 (30%)	
Female	3237 (70%)	625 (70%)	
Anticoagulation			0.005*
Yes	1075 (24%)	165 (19%)	
No (including acetylsalicylic acid)	3419 (76%)	683 (81%)	
Age [in years]			< 0.001*
Median (IQR)	85 (80–89)	79 (75–83)	
Living situation prior to surgery			< 0.001*
Home	3345 (73%)	758 (87%)	
Nursing home	1124 (25%)	98 (11%)	
Hospital	69 (2%)	11 (1%)	
Other	22 (0%)	4 (0%)	
Further injuries			0.618
No	4231 (91%)	817 (92%)	
Yes	402 (9%)	72 (8%)	
Walking ability before injury			< 0.001*
Unknown	314 (7%)	41 (5%)	
Independent without walking frame	1337 (29%)	541 (61%)	
Out of house walking with one crutch	573 (12%)	86 (10%)	
Out of house walking with two crutches or other walking frame	1371 (30%)	138 (16%)	
Certain walking ability within apartment, outside only with auxiliary person	882 (19%)	73 (8%)	
No functional walking ability	141 (3%)	5 (1%)	

HA hemiarthroplasty, *THA* total hip arthroplasty, *ASA* American Society of Anesthesiologists, *ISAR* Identification-of-Seniors-At-Risk, *IQR* interquartile range

*Significant differences. *p* value was calculated by the χ^2 test for categorical data and Mann–Whitney *U* test or Kruskal–Wallis test for continuous data

Table 2 Post-surgery differences between the HA and THA groups before propensity score matching

	HA $N=4662$	THA $N=892$	p value
Deceased during hospital stay	258 (6%)	22 (3%)	< 0.001*
Time in hospital of surviving patients [days], median (IQR)	16.1 (11.0–23.0)	13.1 (10.1–19.0)	< 0.001*
Time in hospital of deceased patients [days], median (IQR)	9.0 (4.0–19.1)	9.1 (6.1–17.1)	0.596
Walking ability 7 days postoperative			< 0.001*
Unknown	140 (3%)	15 (2%)	
Without walking aids	33 (1%)	11 (1%)	
With walking crutches	378 (8%)	304 (34%)	
With rolling walker	1,482 (32%)	229 (26%)	
Not possible	931 (20%)	76 (9%)	
With walking frame	805 (17%)	123 (14%)	
With wheeled walker	833 (18%)	127 (14%)	
Re-surgery during in-house stay**	168 (4%)	27 (3%)	0.460
Reduction	15 (9%)	7 (26%)	
Irrigation and debridement	90 (54%)	12 (44%)	
Implant removal	9 (5%)	7 (26%)	
Girdlestone surgery	1 (1%)	1 (4%)	
Periprosthetic fracture	11 (7%)	2 (7%)	
Other	59 (35%)	12 (44%)	

HA hemiarthroplasty, *THA* total hip arthroplasty

*Significant differences; **multiple responses possible. p value was calculated by the χ^2 test for categorical data and Mann–Whitney U test or Kruskal–Wallis test for continuous data

day 120 postoperatively, while significance was not verifiable after propensity score matching. Other studies reported no clear distinction in mortality between groups [21, 29]. Several factors may lead to a higher mortality rate in the HA group: patients were significantly older, had a higher ASA and ISAR grade, and took anticoagulants more often. Patients were treated more often with HA on nationwide holidays and during nonworking hours. This could lead to a suboptimal preoperative preparation and reduced surgical experience, described as the "weekend effect" [30, 31].

A regular geriatric ward round is necessary for certification as ATZ, and should improve transition from acute hospital to rehabilitation institution, coinciding with the needs of the multimorbid patient, starting at admission in the acute hospital. Comparing in-house mortality rate and that rate 120 days postoperatively, with the latest publications, we were affected by additional medical advice. Gundel et al. shows an overall mortality rate after hip fracture in Denmark of 16% at 90 days postoperatively [32]. The positive influence on mortality rate of an orthogeriatric team was described by Lisk et al., showing a decrease from 7.8 to 5.3% after implementing the team, confirmed by several meta-analyses and observational studies [18, 33, 34]. The same effect was reported by Knobe et al. with a decrease in mortality from 9 to 2% after orthogeriatric co-management was established [19].

Avoiding additional surgery and/or treatment for the same injury is essential for elderly patients. Therefore, we analysed the surgery-associated complications rate after HA and THA, and found a higher risk of hip joint dislocation in the THA group within 120 days. Baker et al. showed a rate of 7.5% joint dislocation after THA in a 30-day follow-up, while there was no dislocation in the HA group [35]. Van den Bekerom et al. conducted a 5-year follow-up in 2010 and presented a significantly higher rate of dislocation in the THA group [36]. Several meta-analyses support the higher risk of dislocation after THA [22, 23]. A recently published RCT did not find significant differences on secondary procedures following THA or HA. Patients younger than 70 years of age were also included in this study [24]. Another RCT published in 2007 by Blomfeldt et al. reported no differences in complication rates between THA and HA, but excluded patients with severe cognitive deficits, institutionalized patients, and a need for walking aids, as Macaulay et al. did in 2008 [7, 9]. The readmission rate within 120 days was 4% in the HA and 8% in the THA group, with less readmissions than overall readmission rate of the ATR [37]. A study from Taiwan showed a readmission rate in nonagenarians of 24.1% within the first 3 months after hip fracture [38]. Due to lack of comparable studies, we highlight our data for further investigations.

Table 3 Results of the optional follow-up 120 days after surgery before propensity score matching

	HA $N = 2110$	THA $N = 399$	*p* value
Mortality	168 (11%)	20 (6%)	0.003*
Readmission			0.219
Yes	104 (5%)	26 (7%)	
No	1987 (95%)	366 (93%)	
Walking ability 120 days after surgery	1522	332	< 0.001*
Independent without walking frame	130 (9%)	99 (30%)	
Out of house walking with one crutch	174 (11%)	56 (17%)	
Out of house walking with two crutches or other walking frame	633 (42%)	121 (36%)	
Certain walking ability within apartment, outside only with auxiliary person	380 (25%)	32 (10%)	
No functional walking ability	205 (13%)	24 (7%)	
Re-surgery after readmission during 120 days after surgery**	80 (4%)	30 (8%)	0.002*
Reduction	12 (15%)	9 (30%)	
Irrigation and debridement	37 (46%)	11 (37%)	
Implant removal	8 (10%)	0	
Conversion into THA	13 (16%)	0	
Girdlestone resection	1 (1%)	0	
Periprosthetic fracture	9 (11%)	1 (3%)	
Other	21 (26%)	9 (30%)	

HA hemiarthroplasty, *THA* total hip arthroplasty

*Significant differences; **multiple responses possible. *p* value was calculated by the χ^2 test for categorical data and Mann–Whitney *U* test or Kruskal–Wallis test for continuous data

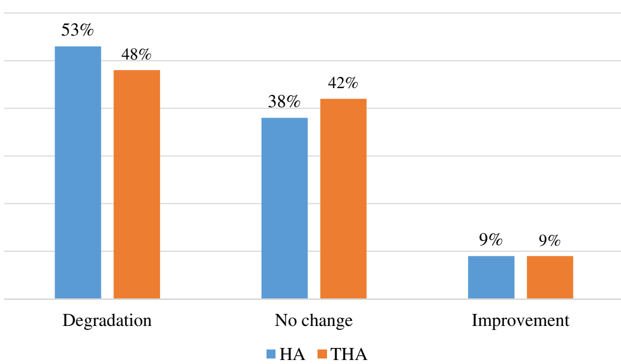

Fig. 1 Percentage distribution of changes in walking ability. Preinjury walking ability was compared to the walking ability 120 days after surgery. The overall differences between the hemiarthroplasty (HA) and the total hip arthroplasty (THA) were not statistically different ($p = 0.271$)

Although HA was associated with less postoperative surgical complications, the patients did not achieve the same results with respect to walking ability. Yet, the distribution of walking ability was not significantly different, with a degradation in mobility of 62% in the HA group and 51% in the THA group; the THA group presented significantly more independent walking without use of a frame. This compares to Dyer et al., showing the reduction of mobility in 40–60% of patients postoperatively for hip fracture [39]. Independent walking in the THA group confirms other studies' outcomes, though we focused on walking with or without aids, whereas other studies analysed function via the Oxford Hip Score or Harris Hip Score [7, 9, 35].

A correlation existed between walking ability and QoL, as measured by the EQ-5D-3L. Seven days postoperatively, the EQ-5D-3L was not significant, but after 120 days it became significant, signifying that patients provided with THA present with less problems regarding mobility, self-care, daily activities, pain/discomfort, and anxiety/depression [40].

There are several limitations in our study: first, it was a retrospective analysis, but data for the ATR-DGU were collected prospectively. Second, only certified hospitals were involved in the ATR-DGU, as all patients were treated with orthogeriatric management. Thus, transmission to standard orthopaedic treatment was not possible. Another limitation is that follow-up 120 days postoperatively is optional, showing less included patients and potential selection bias. Moreover, no longer time periods of the follow-up are provided by the ATR-DGU. Furthermore, no other complications, for example cardiovascular complications,

Table 4 Propensity matching according to ASA grade, ISAR Score, anticoagulation, sex, age, walking ability before fracture and percentage distribution within the analysed data

	Before matching *N* = 3372			After 2 HA to 1 THA matching *N* = 1335		
	HA *N* = 2859	THA *N* = 513	*p* value	HA *N* = 864	THA *N* = 471	*p* value
ASA grade			< 0.001*			0.152
1–2	602 (21%)	215 (42%)		302 (35%)	184 (39%)	
3–5	2257 (79%)	298 (58%)		562 (65%)	287 (61%)	
Isar Score			< 0.001*			0.198
< 2	451 (16%)	223 (43%)		300 (35%)	181 (38%)	
≥ 2	2408 (84%)	290 (57%)		564 (65%)	290 (62%)	
Anticoagulation			0.106			0.717
No	2165 (76%)	406 (79%)		682 (79%)	367 (78%)	
Yes	694 (24%)	107 (21%)		182 (21%)	104 (22%)	
Sex			0.760			0.357
Male	847 (30%)	156 (30%)		270 (31%)	135 (29%)	
Female	2012 (70%)	357 (70%)		594 (69%)	336 (71%)	
Age [years]			< 0.001*			0.095
Median (IQR)	84 (80–89)	79 (75–83)		80 (77–84)	79 (77–83)	
Walking ability before fracture			< 0.001*			0.75
Independent	887 (31%)	328 (64%)		509 (59%)	286 (60%)	
Out of house with walking aids	1307 (46%)	140 (27%)		263 (30%)	140 (30%)	
Little to non-functional walking ability	665 (23%)	45 (9%)		92 (11%)	45 (10%)	

HA hemiarthroplasty, *THA* total hiparthroplasty, *ASA* American Society of Anesthesiologists, *ISAR* Identification-of-Seniors-At-Risk, *IQR* interquartile range

*Significant differences *p* value was calculated by the χ^2 test for categorical data and by theMann–Whitney *U* test or Kruskal–Wallis test for continuous data

than surgical complications, no reasons for mortality, no information about the surgeons' experiences, no information of the decision-making process for treatment selection, no validated scores for walking ability and no data from a possible intensive care treatment are part of the ATR-DGU, and therefore, are not available for analyses. Nevertheless, our study focused on patients aged 70 years or older and who were treated exclusively with orthogeriatric co-management. No exclusions criteria depending on patients' conditions, such as dementia or care-dependency, were defined. Therefore, our study is unique in regard to the patients included in this study. Due to the comorbidities and cognitive impairments, the follow-up examinations in geriatric patients are often only possible to a limited extent. Therefore, analyses of clinical registers like the ATR-DGU, could led to an increased knowledge in this patient group.

In summary, a recommendation for one treatment option without considering preoperative health status and mobility is not possible. THA is preferred in healthier and more mobile patients, with increased walking ability and higher QoL, while HA is better for multimorbid patients to avoid more surgeries and/or medical treatment, more complications, and embarrassing outcomes. The patient age might of less importance. As all included patients were treated in an orthogeriatric co-management, a comparison of our results with standard orthopaedic treatment was not possible. The comparison was made in regard to the existing literature.

Table 5 Results of selected variables after propensity score matching and percentage distribution within the analysed data

	After 2 HA to 1 THA matching $N = 1335$		
	HA $N = 864$	THA $N = 471$	*p* value
Time-to-surgery [h]			0.007*
Median (IQR)	20.38 (9.5–27.3)	21.2 (14.3–33.1)	
Deceased in-house			0.176
Yes	32 (4%)	12 (3%)	
No	810 (96%)	446 (97%)	
Deceased within 120 days			0.540
Yes	14 (5%)	5 (3%)	
No	278 (95%)	156 (97%)	
Walking ability after fracture (120-day follow-up)			0.001*
Independent, without walking frame	52 (18%)	46 (28%)	
Out of house walking with one walking crutch	50 (17%)	32 (19%)	
Out of house walking with two walking crutches or other walking frame	111 (38%)	63 (38%)	
Certain walking ability within apartment, outside only with auxiliary person	53 (18%)	16 (10%)	
No functional walking ability	28 (10%)	8 (5%)	
Walking ability after fracture (120-day follow-up)			0.062
Degradation	181 (62%)	84 (51%)	
No change	98 (33%)	67 (41%)	
Improvement	15 (5%)	14 (8%)	
Re-surgery during in-house**	27 (3%)	14 (3%)	1
Reduction	0	(29%)	
Irrigation and debridement	19 (70%)	7 (50%)	
Implant removal	0	4 (29%)	
Girdlestone resection	0	1 (7%)	
Periprosthetic fracture	1 (4%)	1 (7%)	
Other	8 (30%)	5 (36%)	
Re-surgery within 120 days**	16 (4%)	20 (10%)	0.006*
Reduction	0	7 (35%)	
Irrigation and debridement	9 (56%)	9 (45%)	
Implant removal	2 (12%)	0	
Conversion in THA	3 (19%)	0	
Girdlestone resection	0	0	
Periprosthetic fracture	1 (6%)	0	
Other	3 (19%)	4 (20%)	
EQ-5D-3L Index after 7 days, median (IQR)	0.7 (0.38–0.8)	0.7 (0.49–0.79)	0.068
EQ-5D-3L Index after 120 days, median (IQR)	0.81 (0.70–1.0)	0.9 (0.72–1.0)	0.01*

IQR interquartile range

*Significant differences; **multiple responses allowed. *p* value was calculated by the χ^2 test for categorical data and Mann–Whitney *U* test or Kruskal–Wallis test for continuous data

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Compliance with ethical standards

Conflict of interest All the authors certify that they have no affiliations with or involvement in any organisation or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethics Written patient consent was obtained by participating hospitals. The data from the ATR-DGU received full approval from the Ethics Committee of the medical faculty of the Philipps-University, Marburg, Germany (AZ 46/16).

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