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HIP ARTHROPLASTY

Periprosthetic fracture following anterior approach or dislocation after posterior approach: which one is the lesser evil?

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Abstract

Introduction The most common approaches in total hip arthroplasty (THA) have different complication profiles; anterior-approach (AA-THA) has an increased risk of periprosthetic fractures (PPF); posterior-approach (PA-THA) is associated with higher dislocation risk. However, the relative severity of one versus the other is unknown. This study aims to compare outcome of patients who suffered PPF after AA-THA with those that sustained dislocation after PA-THA.

Methods This is a retrospective, single-center, multi-surgeon, consecutive case-series of primary THA patients. In a cohort of 9867 patients who underwent THA, 79 fulfilled the approach-specific, post-operative complication criteria, of which 44 were PPF after AA-THA and 35 with dislocation after PA-THA (age 67.9 years (range: 38.0–88.1), 58.2% women). Outcome included complication- and revision- rates, and patient-reported outcomes including Oxford Hip Score (OHS).

Results At 5.8 years follow-up (range: 2.0–18.5), reoperation was more common in the dislocation after PA-THA group (23/35 vs. 20/44; $p=0.072$). Change of surgical approach occurred in 15/20 of patients with PPF after AA-THA, but none in those with dislocation after PA-THA. Following re-operation, complication rate was greater in the PPF group (9/20 vs. 4/23; $p=0.049$). At latest follow-up, OHS were superior in the PPF after AA-THA group [42.6 (range: 25.0–48.0) vs. 36.6 (range: 21.0–47.0); $p=0.006$].

Conclusion Dislocation following PA-THA is more likely to require revision. However, PPF following AA-THA requires more often a different surgical approach and is at higher risk of complications. Despite the increased surgical burden post-operative PROMs are better in the peri-prosthetic fracture group, especially in cases not requiring reoperation.

Level of evidence III, case–control study

Keywords Total hip arthroplasty · Approach · Peri-prosthetic fracture · Dislocation · Outcome · Complications

Introduction

The three most common approaches [posterior (PA), lateral, and anterior (AA)] for total hip arthroplasty (THA), have well-documented advantages and disadvantages [1–4]. AA has recently gained popularity [5, 6], because it is an inter-nervous and inter-muscular approach [2, 7], offering advantages such as enhanced recovery, decreased postoperative pain, and decreased dislocation rates [8, 9]. Despite these presumed advantages, several studies have failed to show a distinct advantage of AA over PA on the long term [1, 3, 10, 11].

Opponents of AA have reported higher rates of complications associated with AA [12–15], because it is associated with technical difficulties, mainly on the femoral side [13], where soft tissues may impede access, increasing risk of component mal-positioning and periprosthetic fractures [16], described in 1–3% of primary cases [17, 18]. However, AA-THA in supine position has been shown to lead to superior reconstruction and component orientation accuracy [19, 20]. Traditionally, PA is associated with a higher dislocation risk compared to AA [1]. Whilst this risk, ranging between 1 and 3% [21], has decreased over the years with the use of

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higher femoral head sizes [22] and posterior capsular repair [23, 24], recent studies still favour AA over PA in terms of stability [25–28].

Which approach is more appropriate for a specific patient, does not only depend on the likelihood of certain complications, but also the consequences of these complications. Little is known which of these types of complications, dislocation associated with PA-THA or peri-prosthetic fracture associated with AA-THA, has greater impact on outcome. Generally, comparative studies on THA approaches remain inconclusive, partially because the impact of these complications is not studied extensively in an approach-specific pattern [1, 29]. In other words, whilst previous literature has assessed the outcome of peri-prosthetic fractures [30, 31] or dislocations [32–34] separately, no study has directly compared the influence of these complications on patient satisfaction.

The goal of this study was to compare medium-term clinical outcome (using objective and subjective measures) of patients who sustained a dislocation following PA-THA and patients that suffered a peri-prosthetic fracture after AA-THA. Outcome measures included complication-, reoperation- rates, and patient-reported outcome measures (PROMs). We hypothesized patients who sustained a peri-prosthetic fracture following AA-THA would have a higher likelihood to need a subsequent reoperation and thus exhibit inferior PROMs at follow-up.

Methods

Study design

This is a retrospective, single-center, multi-surgeon, consecutive case-series of primary THA patients who experienced either dislocation after PA-THA or peri-prosthetic fracture after AA-THA at a large, academic, tertiary care center (The Ottawa Hospital, Ottawa, Ontario, Canada). The study was approved by the Institutional Review Board.

An a-priori sample size calculation was performed in SPSS v28 (IBM Corp, New York, United States). Previous studies have shown a mean Oxford Hip Score (OHS) of 29 ± 8 among patients who sustained a peri-prosthetic fracture rate [35], and a mean OHS of 35 among patients who were revised for a THA dislocation [33]. Based on this data, a minimum of 28 cases per group was needed to achieve sufficient power ($1\text{-}\beta = 0.95$, $\alpha = 0.05$).

Study population

We enquired the institute's database to identify consecutive patients who were treated with primary THA and sustained either a dislocation or a periprosthetic after THA between January 1st, 2002, and December 31st, 2020 (dislocations), and between January 1st, 2014, and December 31st, 2020 (peri-prosthetic fractures), with a minimum follow-up of 2 years. Patients with dislocation after PA-THA were excluded if they underwent bipolar hemiarthroplasty or hip resurfacing arthroplasty (n = 20), in case of missing data on dislocations or approach (n = 8), if dislocation was secondary to fracture or infection (n = 2) or if the first dislocation was more than 5 years after surgery and therefore might have been related other causes than the approach (i.e. polyethylene wear) (n = 10). Patients with peri-prosthetic fracture after AA-THA were excluded if they sustained intra-operative calcar cracks (n = 3); acetabular fracture (n = 2); fractures occurred due to high-energy trauma; or fractures occurring more than 90 days post-operatively (n = 5). Application of these criteria left 79 patients for inclusion: 35 patients with a dislocation after PA-THA and 44 patients with a peri-prosthetic fracture after AA-THA (Fig. 1). Peri-prosthetic fractures were graded as per Vancouver classification [36]: there were 14 Vancouver-A (16.3%), 15 Vancouver-B1 (20.0%), 11 Vancouver-B2 (13.8%) and 4 Vancouver-B3 (5.0%) peri-prosthetic fractures. Peri-prosthetic fractures took place on average 15 days (range: 0–60 days) following primary THA. Dislocations occurred on average 196 days post-operatively (range: 6–1,435 days) ($p < 0.001$). Length of follow-up was determined from the date of surgery to the last clinical review or time of death [37].

The cohort's mean age was 67.9 years (range: 38.0–88.1). There were 46 women (58.2%) and 33 men (41.8%), with a mean BMI of 27.8 kg/m^2 (range: 18.0–50.0). Most patients were ASA (American Society of Anesthesiologists) grade 2 (31.6%) or 3 (58.2%). There were no differences between both groups in age ($p = 0.961$), sex ($p = 0.862$), BMI ($p = 0.294$) or ASA-grade ($p = 0.523$). Follow-up was longer in patients with a dislocation after PA-THA compared to patients with a peri-prosthetic fracture after AA-THA [9.4 years (range: 2.0–18.5) vs. 4.1 years (range: 2.0–7.3); $p < 0.001$] (Table 1).

Surgical technique

AA-THAs were performed with patients positioned supine on a standard operating table (n = 8) [7] or using a positioning table (n = 36) [2]. AA-THA patients were allowed weight-bearing as tolerated post-operatively with anterior hip precautions. Institutional experience with AA-THA has previously been reported [38, 39]. All PA were performed with patient in a lateral decubitus position [40, 41]. External rotators and posterior capsule were taken down and repaired after the procedure in a standard fashion. Gluteus maximus tendon was not released in any of the cases. PA-THA patients were allowed weight-bearing as tolerated with posterior hip precautions during the first 6 weeks. All

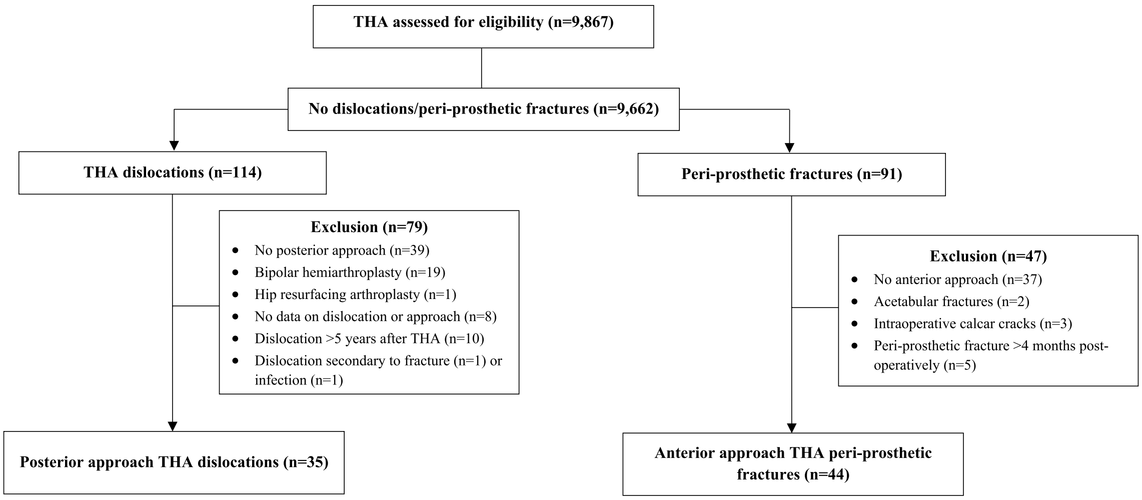

Fig. 1 Flowchart of the inclusion process of the study

Table 1 Demographics of the cohort

	Whole cohort (n = 79)	Fracture group (n = 44)	Dislocation group (n = 35)	p-value
Age (years) [mean ± SD (range)]	67.9 (38.0–88.1)	67.8 (38.0–87.0)	68.1 (45.4–88.1)	0.961[c]
Sex				0.862[d]
Female (n, %)	46 (58.2)	26 (59.1)	20 (57.1)	
Male (n, %)	33 (41.8)	18 (40.9)	15 (42.9)	
BMI[a] (kg/m^2) [mean ± SD (range)]	27.8 (18.0–50.0)	27.5 (18.0–48.0)	28.4 (19.0–50.0)	0.294[c]
Follow-up (years) [mean ± SD (range)]	5.8 (2.0–18.5)	4.1 (2.0–7.3)	9.4 (2.0–18.5)	< 0.001[c*]
ASA[b]-score				0.523
ASA I (n, %)	2 (2.5)	1 (2.3)	1 (2.9)	
ASA II (n, %)	25 (31.6)	17 (38.6)	8 (22.9)	
ASA III (n, %)	46 (58.2)	23 (52.3)	23 (65.7)	
ASA IV (n, %)	6 (7.6)	3 (6.8)	3 (8.6)	
Bilateral	4 (5.1)	4 (9.1)	0 (0.0)	0.067[e]
Deceased	14 (17.7)	3 (6.8)	11 (31.4)	0.004[e*]

[a]BMI: Body Mass Index

[b]ASA: American Society Anaesthesiologists score

[c]Mann Whitney U test

[d]Chi-Square test

[e]Fisher's Exact test

[*]Statistically significant (p-value < 0.05)

patients were assessed by physiotherapy before hospital discharge. Routine, 30-day deep venous thrombosis (DVT) prophylaxis was used in all cases. Patients were reviewed clinically at 2-weeks, 6-weeks, 6-months, 12-months, and annually thereafter.

Most used primary acetabular implants were G7® (Zimmer-Biomet, Warsaw, Indiana, United States) (n = 48) and Trident® cup (Stryker, Kalamazoo, Michigan, United States) (n = 6). Most used femoral stems were Microplasty® (Zimmer-Biomet) (n = 39), Taperloc® Complete (Zimmer-Biomet) (n = 6) and Profemur® TL stem (Microport, Shanghai, China) (n = 5). Articulating bearing surface was metal-on-polyethylene. Most stems were uncemented (n = 76; 96.2%). There was no difference in use of cemented implants between both groups (p = 0.427). The majority were 32-mm (43.0%) and 36-mm (50.6%) heads, with no difference between cohorts (p = 0.303). No dual-mobility components were used.

Outcome measurements

Outcome measures included surgical-related intraoperative and postoperative complications, and reoperations. The Clavien-Dindo classification was used to grade complications [42]. Grade 1 complications needed no treatment, grade 2 complications required pharmacologic treatment, grade 3 complications included dislocation, infection, fracture or aseptic loosening. Grade 4 complication were potentially life-threatening complications such as pulmonary embolism, and grade 5 complications resulted in death.

Patient-reported outcome measures (PROMs) were obtained at minimum 12 months postoperatively for all patients. These included the Oxford Hip Score (OHS) [43] (0–48; worse to best) and EuroQoL Five Dimensions Questionnaire [44] (-0.594 to 1.000; worse to best).

Statistical analysis

Statistical analysis was performed using SPSS v28 (IBM). Normal distribution of data was tested with the Kolmogorov–Smirnov test and Q-Q plots, showing no normal distribution of data. A Mann Whitney-U test or a Kruskal–Wallis test was used to compare continuous variables, and Chi Square test to compare categorical variables. Survival data was obtained by Kaplan–Meier analysis [45]. A p-value of < 0.05 was considered to indicate statistical significance.

Results

Complications & reoperations

No patients deceased in the first year of follow-up, the 5-year mortality rate was 4.5% in the peri-prosthetic fracture group and 8.6% in the dislocation group (p = 0.465).

Twenty periprosthetic fractures (45.5%) and 23 dislocations (65.7%) required subsequent surgical treatment (p = 0.072), the rest were treated non-operatively. Periprosthetic fractures that were treated non-operatively were either Vancouver-AG (n = 11), Vancouver-AL (n = 1) or Vancouver-B1 [Intra-operative calcar crack (n = 3) or cortical perforation (n = 2), minimally/non-displaced fracture at early follow-up (n = 7)] (Fig. 2). Fractures treated surgically were Vancouver-AG (n = 2), Vancouver-B1 (n = 3), Vancouver-B2 (n = 11) or Vancouver-B3 (n = 4). Majority of reoperations in both groups were revision THA, including stem and/or cup revision (17/20 vs. 11/23; p = 0.022). Two patients with a Vancouver-A peri-prosthetic fracture were treated with a head-liner exchange to enhance stability (Fig. 3).

Whilst all revisions of PA-THA dislocations were done through the same approach, peri-prosthetic fractures of AA-THA could only be revised in 25.0% of cases through an anterior approach (n = 5), 5.0% through a lateral (n = 1) and 70.0% was revised through a posterior approach (n = 14). Patients with a peri-prosthetic fracture after AA-THA that needed a reoperation more often developed Dindo-Clavien grade 3 complication after revision (9/20 vs. 4/23; p = 0.049). The majority of these were infection (8/21 vs. 1/23; p = 0.007) (Fig. 4). A different approach was used in cases of an infection post-revision of peri-prosthetic fracture, treated with revision of implants (n = 6/8), the same approach was used in cases where only a head-liner exchange was used as treatment (n = 2/8),

Nine patients of the peri-prosthetic fracture group required a second reoperation (20.5%) compared to four in the dislocation group (11.4%) (p = 0.051) (Fig. 4). There was no difference in complication rate between both groups in cases of a second reintervention (p = 0.333).

For endpoint implant revision, a survival of 64.3% among peri-prosthetic fracture following AA-THA vs. 65.6% among dislocation following PA-THA was found at 5-year follow-up using Kaplan–Meier (log rank p = 0.104) (Fig. 5).

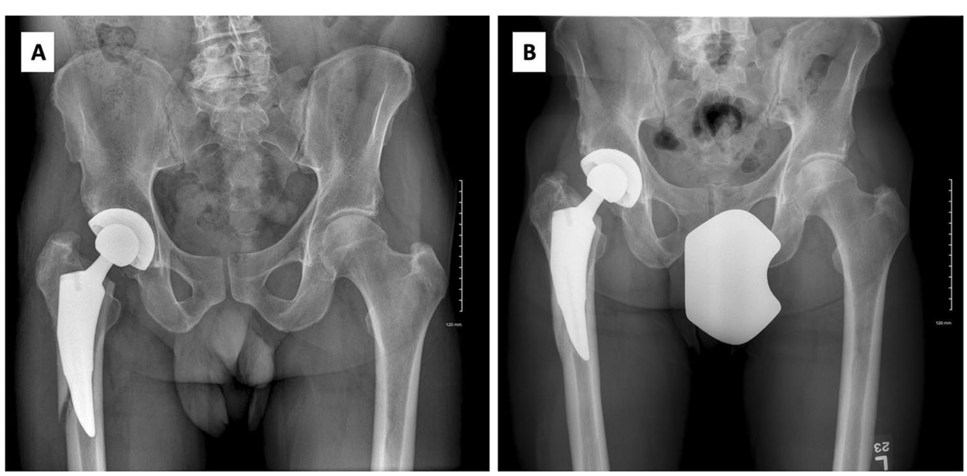

Fig. 2 Example of a Vancouver-B1 peri-prosthetic fracture with evidence of implant subsidence (**A**). This fracture was treated non-operatively with evidence of healing at latest follow-up (**B**)

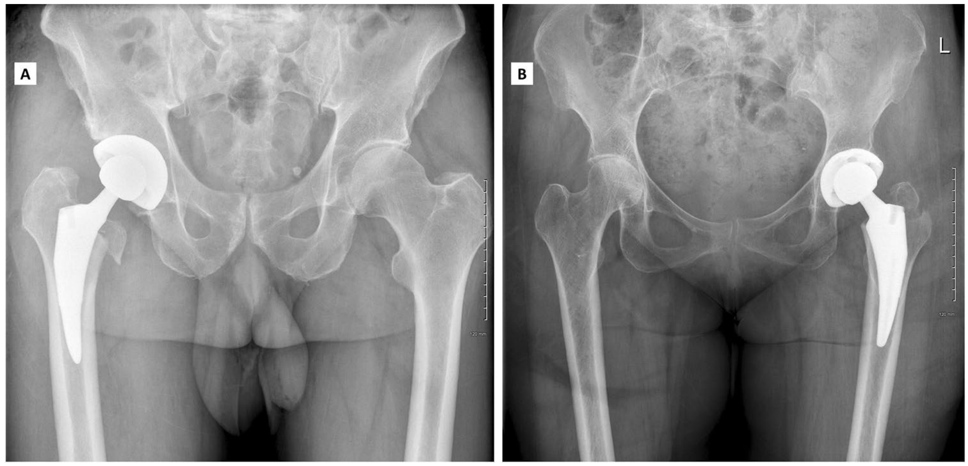

Fig. 3 Example of Vancouver-AL (A) and -AG (B) peri-prosthetic fractures treated with head-liner exchange

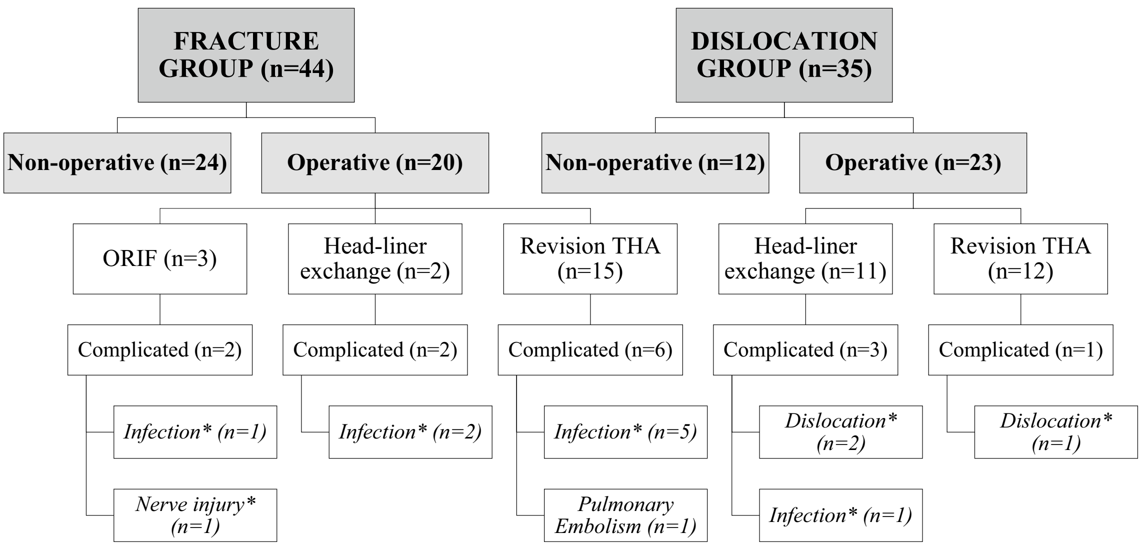

Fig. 4 Treatment and subsequent complications in both groups (*indicating complication treated with reoperation)

Patient-reported outcome measures

Among alive patients at follow-up, PROM scores could be obtained for 82% of patients. Patients who sustained peri-prosthetic fracture after AA-THA had higher final PROMs s than those who sustained dislocation after PA-THA. Mean post-operative OHS at latest follow-up was 42.6 (range: 25.0–48.0) among patients with peri-prosthetic fracture, compared to 36.6 (range: 21.0–47.0) among those with a dislocation (p = 0.006); and EQ5D was also higher [0.746 (range: 0.102–1.000) vs. 0.697 (range: 0.424–1.000); p = 0.194)].

Peri-prosthetic fractures treated non-operatively had highest OHS scores compared to dislocations treated conservatively [42.0 (range: 25.0–48.0) vs. 37.3 (range: 27.0–47.0); p = 0.056]. Similarly, peri-prosthetic fractures treated surgically had higher final OHS scores [43.0 (range: 25.0–48.0) vs. 32.0 (range: 21.0–43.0); p = 0.115].

Highest OHS scores were found in patients with Vancouver-A/B1 [mean 43.9 (range: 25.0–48.0)], compared to patients with Vancouver-B2/3 [mean: 39.7 (range: 25–48.0)] and dislocation patients [mean: 36.6 (range: 21.0–47.0)] (p = 0.010) (Fig. 6).

Discussion

The optimum approach for THA is a matter of continuous debate and is likely surgeon- and patient- dependent. By extracting data from a large, multi-surgeon, database at a single academic tertiary institution, we were able to compare medium to long term outcome of patients who sustained a dislocation after PA-THA versus those who sustained a

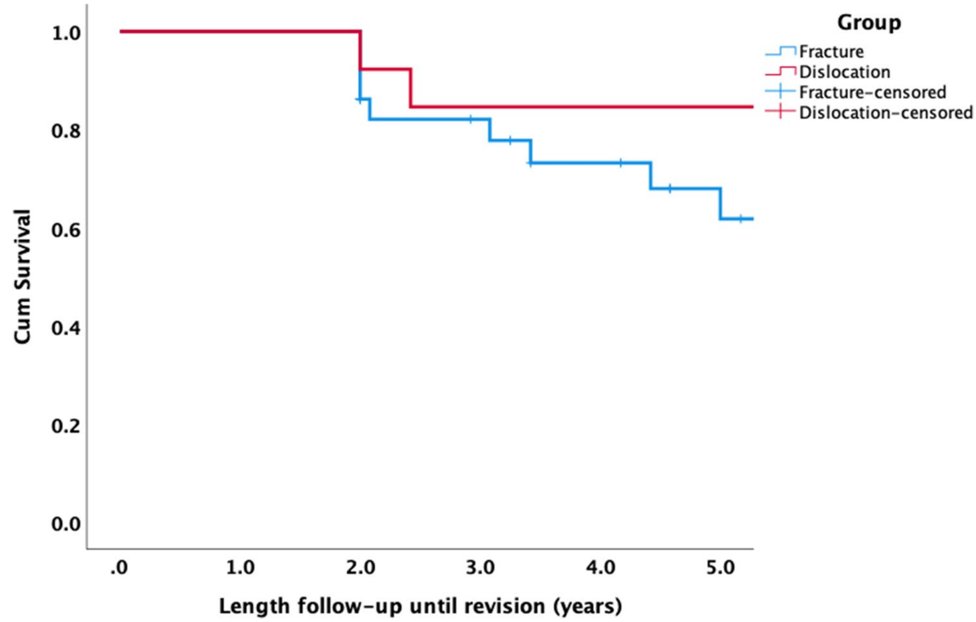

Fig. 5 Kaplan–Meier survival analysis using implant revision (acetabular cup or femoral stem) as end-point (blue: peri-prosthetic fracture after AA-THA; red: dislocation after PA-THA)

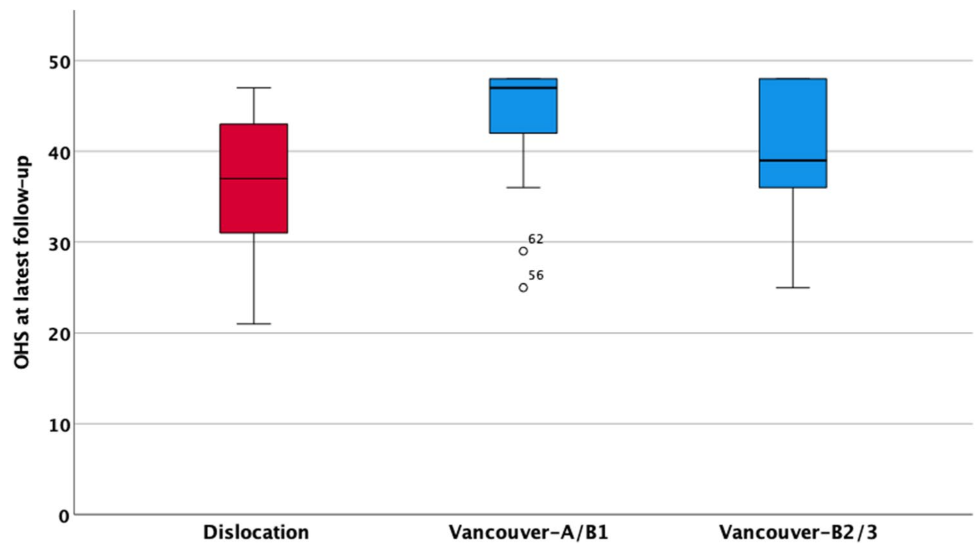

Fig. 6 Boxplot comparing Oxford Hip Score (OHS) at final follow-up between different peri-prosthetic

peri-prosthetic fracture after AA-THA. Both complications were associated with significant patient burden. The complication rate following revision surgery was higher in patients with a peri-prosthetic fracture. Whilst the overall surgical burden in patients with dislocations following PA-THA was lower, PROM scores of these patients at final follow-up were worse. Patients with a peri-prosthetic fracture managed non-operatively, as expected had best PROMs, equivalent to non-complicated, primary THAs. These results emphasize that THA instability has a significant impact on patient' satisfaction, in line with previous studies [29, 33], that should not be undermined, even when further surgery is not required or when surgery performed is relatively minor (head-liner exchange).

In this study, whilst dislocations led more often to a reoperation, the complication rate following revision surgery was much higher in the peri-prosthetic fracture group, primarily due to the increased infection rate. A large proportion of patients with a periprosthetic fracture after AA-THA (76%) underwent revision through a different approach, whilst patients with a dislocation after PA-THA were always be operated through the same approach. Although posterior approach is an easier extensile approach to address femoral peri-prosthetic fractures, some authors have suggested that complex revisions can also be safely conducted through an (extensile) anterior approach [46–48]. Particularly femoral revisions can be quite challenging through an anterior approach due to the proximity of neurovascular structures supplying the quadriceps [49, 50], and femoral revisions through AA-THA are most likely associated with a significant additional learning curve [51]. Most infections occurred when approach was changed, but whether these complications could have been avoided by using the same approach is unsure, because the cause of an infection is multifactorial [52]. The larger femoral exposure that is often needed to reduce a peri-prosthetic fracture, as well as the subsequent increased length of the procedure, and the traumatized tissues as part of the fracture, likely contribute to the increased risk of complications, such as infection [53].

Previous studies have highlighted the burden of THA instability, being associated with a higher mortality rate, and significant functional and financial consequences [32], especially in setting of recurrent instability [33]. The cause of instability is multi-factorial [54], and some of the factors may remain present and affect outcome, even when instability has been resolved. Furthermore, some patients may have ongoing micro-instability or fear of further instability and movement, which may influence PROMs [55]. PROM scores of dislocations in this cohort were comparable to previous studies in patients with instability following THA [33, 56]. PROMs were inferior amongst patients that required revision for instability (OHS: 32), compared to patients treated non-operatively (OHS:37). It has been previously shown that most patients that dislocate following posterior approach are more likely to require re-operation, contrary to those that have had an index anterior approach [1, 29]. PROMs of patients with a peri-prosthetic fracture following AA-THA were significantly better compared to those with a dislocation at final follow-up. When peri-prosthetic fractures following AA-THA were treated conservatively, for example in cases of Vancouver-A/B1 fractures, PROMs scores were superior compared to all other sub-groups. It is reasonable to assume that when a peri-prosthetic fracture heals without the need of a second intervention, the patient has a good chance of returning to high function on the medium- to long-term [57]. PROM scores of these patients would eventually be equivalent to patients without complications after THA. Patients with a peri-prosthetic fracture treated surgically, very often through a different approach at the time of revision, eventually had similar PROM scores to patients with a dislocation, showing that a dual-approach strategy for peri-prosthetic fracture following AA-THA does not compromise final outcome. Such findings should be part of the decision algorithm and shared decision making in patients presenting with the approach-specific complications studied here within.

This study is not without limitations. First, this is a retrospective study and thus suffers from associated biases. There was a significant difference in follow-up between both groups, which was in part due to the evolution in approach use in our unit. Previous research has shown that PROM scores don't significantly change after 12 or 24 months post-operatively [58], and therefore this should not have affected the differences in PROM scores. Secondly, although data was extracted from a large database, overall number of patients with complications were small, which created small comparison groups for this study. Although PROM scores could be retrieved for 80% of the included patients that were alive at latest follow-up, studies in larger cohorts should be conducted to confirm our findings. Third, although there was no difference in ASA grades between groups, it is possible that patients with periprosthetic fractures had certain comorbidities that predisposed them to the development of an infection. Other factors such as pre-operative function, fragility, chronic pain issues and psychological status may have been different between groups creating risk of selection bias. Fourth, although peri-prosthetic fractures following a THA are often contributed to factors related to the surgery that led to failure of fixation and a subsequent peri-prosthetic fracture, it is not unlikely that some of these fractures were of pure traumatic origin. The same may account for some of the dislocations. Although all charts were retrospectively reviewed, and cases of high energy trauma were excluded, complications following a trauma are associated with additional implications on the surrounding soft tissues. If some of traumatic complications were included, these may have influenced the results.

Despite these limitations, this data is valuable in that it is the first to compare the impact of complications frequently associated with popular THA approaches. These findings are to be considered in the decision-making process of which approach is appropriate and when discussing relative risks/benefits prior to THA. Future research should be conducted to identify whether, and if so which, patients may benefit from one approach over the other. High-risk patients for femoral complications (e.g., those with high BMI, secondary osteoarthritis or abnormal anatomy) may benefit more from an easier extensile approach, such as the posterior approach, especially amongst surgeons that are not experienced with AA. Whether certain high-risk patients for dislocations (e.g., stiff or fused spines) may benefit from an anterior approach compared to other approaches is also a matter of future research.

Conclusion

Dislocation following PA-THA is more likely to require revision. However, periprosthetic fracture following AA-THA is likely to require different surgical approach and is 3 × more likely to be associated with additional complications, such as an infection. Despite the increased surgical burden, post-operative PROMs are better in peri-prosthetic fracture after AA-THA, especially in cases not requiring revision of implants, which was associated with worse function.

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Declarations

Conflict of interest Authors declare no conflicts of interest directly related to this study. Separate conflict of interest forms for each author have been uploaded.

Ethical approval This study was approved by the Institutional Review Board of the institution and all patients signed an informed consent.

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