Limbing and patient satisfaction after primary total hip arthroplasty: a registry-based cohort study

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Background and purpose — The influence of postoperative limping on patient satisfaction and amount of limping reduction following THA are not well documented. We (1) assessed if postoperative limping is associated with satisfaction 5 years after THA performed via the lateral or anterior approach; (2) evaluated the influence of surgical approach on amount of limping reduction following THA.

Patients and methods — We conducted a prospective cohort study of primary elective THAs performed in 2002–2013. Limping was assessed before and 5 years after surgery using the Harris Hip limping sub-score. Satisfaction was assessed at 5 years on a 5-point Likert scale. We compared proportions of satisfied patients among groups of limping. Evolution of limping before and after surgery was noted. Analyses were performed overall and stratified by pain and surgical approach. We used univariate and multivariate log-binomial regression models.

Results — 1,257 patients were included (mean age 70 years). 81% had surgery via a lateral and 19% via an anterior approach. Before THA, 60% had moderate to severe limping and all reported pain. After THA, limping and pain improved; 9% of patients were dissatisfied. In multivariate analysis stratified on pain level, limping was associated with higher dissatisfaction. Similar results were obtained after lateral vs. anterior approach.

Interpretation — Postoperative limping impacts patient satisfaction after THA. The association varied by degree of limping and absence or presence of pain. It was independent of surgical approach. 5 years after THA occurrence of limping was largely reduced after both a lateral and an anterior approach, with low evidence of a greater reduction under an anterior approach.

Persistence of symptoms or occurrence of complications following total hip arthroplasty (THA) influences patient satisfaction, a complex subjective phenomenon influenced by several factors. The presence and severity of limping is one of them (1,2). Neuprez et al. found that the patient’s expectation to eliminate the preoperative limping thanks to the surgery was linked to satisfaction (3). Moreover, postoperative limping was associated with more unfulfilled expectations and could be a stigma of disability visible to all with an adverse psychological impact affecting patient satisfaction (3,4). Finally, limping could be related to the patient’s pain level impacting their level of mobility during daily life (4).

Several factors can cause postoperative limping: leg length discrepancy, nerve injury, weakness of the gluteal muscles, and surgical approach (5). Most common surgical approaches are posterior (PA), lateral (LA), and direct anterior approach (DAA) (6)—associated with different complication profiles (7-11). Limping has been among the first clinical signs of metal-on-metal prosthesis failure and may be used to monitor implant/provider performance (12-14). It has also been identified as a good predictor of postoperative patient-reported outcomes (15).

The impact of postoperative limping on patient satisfaction, pain, and function is sparsely documented. The main purpose of this study was thus to assess if limping 5 years after surgery is associated with patient satisfaction following primary elective THA performed through the DAA or LA. The secondary purpose was to evaluate the influence of surgical approach on the amount of limping following THA.
Patients and methods

Study design and setting

This study used a prospective register-based cohort from a large tertiary hospital. All patients undergoing primary elective THA for primary osteoarthritis (first hip only) between January 1, 2002 and December 30, 2013 were eligible for the study. For main analyses we included all patients who had a complete preoperative and 5-year clinical follow-up assessment (Figure).

Outcomes

Main outcome was the satisfaction of the patients 5 years after THA. Patients were specifically asked by questionnaire, “Are you satisfied with the result of your hip surgery?” Response categories were: dissatisfied (1), somewhat dissatisfied (2), somewhat satisfied (3), satisfied (4), or very satisfied (5).

The main variables of interest were limping and pain, which were physician-assessed before and 5 years after THA. Limping was evaluated using the corresponding item from the Harris Hip Score (HHS categories: none, slight, moderate, and severe) (16). Pain was evaluated using the HHS pain sub-score (categories no pain, occasional, mild, moderate, and severe or extremely severe pain).

Other data collection

All data was extracted from the Geneva Arthroplasty Registry (17). Assessed baseline data was: age at surgery, sex, BMI, ASA score, Charnley disability grade (grade A, B, C) (18), diabetes, hypertension, ischemic cardiac disease, smoking status, diagnosis, type of fixation (uncemented, hybrid, cemented), and surgical approach used (lateral vs. anterior approach), and duration of the hip symptoms. Variables assessed 5 years after surgery consisted of: hip abductor strength using the Medical Research Council Manual Muscle Testing scale (MMT) evaluated by the surgeon (scored using a M0 [No muscle activation] to M5 [Muscle activation against examiner’s full resistance, full range of motion]) (19), leg-length discrepancy in centimeters evaluated by the surgeon, and the use of cane or walking aid evaluated with the HHS assistance sub-score (categories: none, cane for long distance, cane most of the time, one crutch, two crutches, two crutches, or incapacity to walk).

Statistics

Patient characteristics and clinical outcomes (satisfaction, limping, hip pain) were described as mean (SD) for quantitative variables and counts and percentages for qualitative variables.

The primary objective was to assess if limping 5 years postoperative was associated with patient satisfaction 5 years after THA. To address this issue, reported patient satisfaction was dichotomized into either reporting a higher level of satisfaction (including “very satisfied,” “satisfied”) labelled “satisfied” or reporting a poor or medium level of satisfaction (including “somewhat satisfied,” “somewhat dissatisfied,” “dissatisfied”) labelled “dissatisfied.” Proportions of satisfied patients were then compared among groups of limping (none vs. slight vs. moderate to severe) using univariate and multivariate log-binomial regression models. In the multivariate model, limping effect was adjusted for sex, age (≥ 70 vs. < 70) and BMI (≥ 30 vs. < 30). Analyses were stratified by pain level (none, slight/ occasional, moderate/severe). A similar analysis was also performed in subgroups of surgical approach (LA vs. DAA) as a sensitivity analysis without stratifying for pain level.

The secondary objective was to compare the influence of surgical approach on limping 5 years after THA (none vs. slight to severe). Risk of limping was compared between the 2 groups (DAA vs. LA) using univariate and multivariate log-binomial regression models. In the multivariate model, surgery effect was adjusted for degree of preoperative limping, sex, age, and BMI. Whether preoperative duration of hip symptoms, postoperative pain, hip abductor strength (dichotomized in: ≥ M4–M5 vs. < M4), leg-length discrepancy (dichotomized in: none between –1 cm and +1 cm vs. > +1 cm or < –1 cm) and walking with cane (dichotomized in: no [none] vs. yes [cane for long distance, cane most of the time, 1 crutch, 2 crutches, 2 crutches, or incapacity to walk]) were associated with postoperative limping was evaluated with a chi-square test as post-hoc analyses.

Statistical significance was assessed at a 2-sided 0.05 level for all analyses. All analyses were performed using STATA software, version 13.1 (StataCorp LP, College Station, TX, USA).
Table 4. Influence of postoperative limping on patient satisfaction 5 years after surgery, stratiﬁed by pain level

| 5 years after surgery | All patients | Satisfied | Dissatisﬁed | Crude RR (CI) | Adjusted RR (CI) |
|-----------------------|--------------|-----------|--------------|---------------|-----------------|
|                       | n (%) a      | n = 1,144 | n = 113      |               |                 |
| No pain               | 838 (70)     | 815 (69)  | 23 (5)       | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |
| Slight limping        | 117 (14)     | 111 (95)  | 6 (5)        | 4.8 (1.7–14)  | 5.4 (1.8–16)    |
| Moderate/severe limping | 60 (17)   | 50 (83)   | 10 (16)      | 4.6 (3.1–14)  | 18 (6.9–46)     |
| Slight/occasional pain| 337 (51)     | 288 (86)  | 49 (14)      | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |
| Moderate/severe pain  | 24 (9)       | 16 (67)   | 8 (33)       | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |
| Slight mild limping   | 26 (10)      | 15 (58)   | 11 (42)      | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |
| Moderate/severe limping | 32 (9)   | 10 (31)   | 22 (69)      | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |

RR = Risk ratio; CI = 95% conﬁdence intervals

a Column percentages.
b Row percentages.
c Adjusted for age, sex, BMI.

Table 5. Impact of surgical approach on limping 5 years after THA

| 5 years after surgery | All patients | Postoperative limping | Crude RR (CI) | Adjusted RR (CI) |
|-----------------------|--------------|-----------------------|---------------|-----------------|
|                       | n (%) a      | n = 1,144 | n = 113      |               |                 |
| Surgery approach      | 1,257(90)    | 879 (70)  | 378 (30)     | 1.0 (1.0–1.6) | 1.2 (0.9–1.6)   |
| Anterior              | 234 (19)     | 177 (76)  | 57 (24)      | 1.0 (1.0–1.6) | 1.0 (1.0–1.6)   |
| Lateral               | 1,023 (81)   | 702 (69)  | 321 (31)     | 1.3 (1.0–1.6) | 1.2 (0.9–1.6)   |

Footnotes: see Table 4.

The magnitude of the association varied by degree of limping and degree of pain (Table 4). Among patients without pain (n = 838), 23 were dissatisﬁed (2.7%) and the presence of slight and of moderate to severe limping was associated with dissatisfaction (adjusted RR_{slight} = 5.3, 95% CI 1.8–16 and adjusted RR_{moderate to severe} = 18, CI 6.9–46). In patients with concomitant slight or occasional pain (n = 337), 49 patients were dissatiﬁed (15%), and the presence of slight and of moderate to severe limping was associated with dissatisfaction (adjusted RR_{slight} = 1.2, CI 0.7–2.4 and adjusted RR_{moderate to severe} = 3.6, CI 2.0–6.5). In patients with concomitant moderate or severe pain (n = 82), 41 patients were dissatisﬁed and the presence of slight and of moderate to severe limping was associated with dissatisfaction (adjusted RR_{slight} = 2.1, CI 1.1–3.8 and adjusted RR_{moderate to severe} = 2.0, CI 1.2–3.3). The magnitude of the inﬂuence of limping on dissatisfaction decreased with increasing pain level.

The association between postoperative limping and patient satisfaction was similar in patients operated on with the lateral and the anterior approach in the adjusted analyses (Table C, see Supplementary data).

**Impact of surgical approach on limping 5 years after surgery**

Overall, patients of both groups (LA vs. DAA) shared similar characteristics, except for their mean age (71 vs. 69 years) and a higher proportion of Charnley B in the lateral approach group (37% vs. 26%). 5 years after THA, satisfaction and pain were similar in both groups, but the risk of postoperative limping was 30% higher (RR = 1.3, CI 1.0–1.6) with the lateral approach. In multivariable analysis, this decreased slightly and the conﬁdence interval included 1 (adjusted RR = 1.2, 0.98–1.6), (Table 2, Supplementary data, and Table 5).

**Impact of preoperative duration of symptoms, postoperative pain, hip abductor strength, and leg length discrepancy on limping 5 years after surgery**

5 years after THA, limping was associated with higher pain, lower hip abductor strength, greater leg length discrepancy, and walking with cane. No association was found between postoperative limping and duration of hip symptoms before THA (Table 6).

**Discussion**

Our study shows a negative inﬂuence of postoperative limping on patient satisfaction in patients with and without pain. The inﬂuence of limping on dissatisfaction decreased with increasing pain level. The association between limping and satisfaction 5 years postoperatively was independent of surgical approach. Moreover, 5 years after THA the occurrence of limping was largely reduced after both lateral and anterior surgical approaches. The latter led to a greater reduction in limping occurrence.

We observed that 30% of patients presented limping to any degree after primary elective THA. Mancuso et al. (4) in a prospective cohort study of 487 patients found a similar proportion (31%) 4 years after THA. Limping was assessed by telephone interview. The authors reported that patients with limping had more unfulﬁlled expectations. This is in accordance with our ﬁnding that patients with postoperative limping were more dissatisﬁed than those without. The presence of pain postoperatively is a well-known important contribu-
In conclusion, our findings indicate that the presence of limping and satisfaction was similar for both surgical approaches.

Weakness of the hip muscles can result in abnormal gait patterns and functional disability with lateral bending of the trunk. Nankaku et al. hypothesized that the preoperative gluteus medius muscle atrophy, rather than hip abductor strength, was the best predictor of postoperative limping in the frontal plane after THA. In accordance with these results, we observed that some patients with limping 5 years after surgery had weaker hip abductor strength and/or presence of leg length discrepancy. These 2 factors may be related to the presence of limping and therefore influence gait abilities and functionalities. Weakness of the hip abductor muscles may be a direct cause of Trendelenburg gait and leg-length discrepancy is known to have an effect on the gait asymmetry, lower back pain, and joint compensations with an increase in oxygen consumption due to these gait impairments. The previously mentioned factors are important to co-evaluate, and an understanding of the etiologic of the limping is essential to manage and prevent it.

To our knowledge this is the largest prospective cohort study of THA patients in whom limping was assessed before and 5 years after surgery. Limping is so far sparsely documented in large cohort/registry-based studies, which most often rely on patient-reported outcome measures (PROM) to evaluate postoperative symptoms, and in most of the currently used PROMs (exception Oxford Hip Score) limping is not included. Even if collected, the individual item results of PROMs are rarely presented.

Our study has limitations. First, only 50% of the patients who were eligible have been included in this study, therefore, our results might not be generalizable to the entire population of patients presenting for THA. The second limitation was that our study included a smaller number of patients with an anterior compared with a lateral surgical approach. This is due to the fact that the lateral approach has been used since 2002 whereas the anterior approach was introduced in 2008. Third, no objective information was available concerning the gait functionality of these patients before and after THA, including quantitative measurements such as trunk movement, range of motion of the lower limb joints during gait, or measurement of the hip and knee muscle forces before and after surgery. However, limping was physician-assessed and not patient-reported. Fourth, patients were operated upon by multiple orthopedic surgeons, reflecting the clinical practice of a University Hospital with a large number of surgeries, and different types of prosthesis, techniques, and surgeon experience levels. And finally, the number of patients in the subgroup with postoperative limping and absence of pain was small, leading to large confidence intervals.

In conclusion, our findings indicate that the presence of limping after THA contributes to patient dissatisfaction. The strength of the association varies by severity of limping and absence or presence of concomitant pain.
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### Supplementary Table A. Baseline characteristics prior to total hip arthroplasty (THA) according to patient eligibility. Values are count (%) unless otherwise specified

|                          | Eligible n = 2,577 | Included n = 1,257 | Excluded n = 1,320 |
|--------------------------|---------------------|--------------------|--------------------|
| **Women**                | 1,531 (59)          | 765 (61)           | 766 (58)           |
| **Age at operation, mean (SD)** | 71.2 (9.6)         | 70.5 (8.9)         | 71.8 (10)          |
| **BMI, mean (SD)**       | 27.2 (4.8)          | 27.3 (4.8)         | 27.1 (4.9)         |
| **ASA score**            |                     |                    |                    |
| 1–2                      | 2,038 (79)          | 1,037 (83)         | 1,001 (76)         |
| 3–4                      | 539 (21)            | 220 (17)           | 319 (24)           |
| **Co-morbidities**       |                     |                    |                    |
| Diabetes                 | 265 (10)            | 117 (9)            | 148 (11)           |
| Hypertension             | 1,408 (55)          | 652 (52)           | 756 (57)           |
| Ischemic heart disease   | 218 (8)             | 94 (7)             | 124 (9)            |
| **Smoking status**       |                     |                    |                    |
| Never                    | 1,640 (64)          | 825 (67)           | 815 (62)           |
| Former                   | 463 (17)            | 206 (16)           | 257 (19)           |
| Current                  | 401 (16)            | 191 (15)           | 210 (16)           |
| Unknown                  | 73 (3)              | 35 (2)             | 38 (3)             |
| **Charlley disability grade** |  |  |  |
| A                        | 829 (33)            | 399 (33)           | 430 (34)           |
| B                        | 803 (32)            | 430 (32)           | 373 (30)           |
| C                        | 806 (35)            | 405 (35)           | 461 (36)           |
| **Surgical approach**    |                     |                    |                    |
| Lateral                  | 1,951 (77)          | 1,023 (81)         | 928 (73)           |
| Anterior                 | 570 (23)            | 234 (19)           | 336 (27)           |
| Other                    | 56                  | 56                 |                    |
| **Surgical intervention**|                     |                    |                    |
| Hybrid THA               | 1,747 (68)          | 872 (69)           | 875 (66)           |
| Uncemented THA           | 753 (29)            | 355 (28)           | 396 (30)           |
| Cemented THA             | 77 (3)              | 30 (3)             | 47 (4)             |

### Supplementary Table B. Satisfaction, limping, pain and Harris Hip Score prior to and 5 years after total hip arthroplasty (THA) by surgical approach (N = 1,257). Values are count (%) unless otherwise specified

|                          | Preoperative lateral approach | Postoperative lateral approach |
|--------------------------|--------------------------------|--------------------------------|
| **Satisfaction**         |                                |                                |
| Very satisfied           | –                              | 744 (73)                       |
| Satisfied                | –                              | 188 (18)                       |
| Somewhat satisfied       | –                              | 65 (6)                         |
| Somewhat dissatisfied    | –                              | 21 (2)                         |
| Dissatisfied             | –                              | 5 (1)                          |
| **Harris Hip Limping**   | 1,023 (81)                     | 1,023 (81)                     |
| None                     | 79 (8)                         | 702 (69)                       |
| Slight                   | 315 (31)                       | 206 (20)                       |
| Moderate                 | 470 (46)                       | 90 (9)                         |
| Severe                   | 159 (15)                       | 25 (2)                         |
| **Hips pain**            |                                |                                |
| No pain                  | 0 (0)                          | 688 (67)                       |
| Pain (any level)         | 1,023 (100)                    | 335 (33)                       |
| **Harris Hip score**     | total, mean (SD)               |                                |
|                          | 51 (15)                        | 88 (14)                        |

### Supplementary Table C. Limping and patient satisfaction 5 years after THA using the lateral approach

|                          | All patients | Satisfied | Dissatisfied | Crude RR (CI) | Adjusted RR (CI) |
|--------------------------|--------------|-----------|--------------|---------------|------------------|
| 5 years after surgery    | n (%) | n (%) | n (%) | b | n (%) | b | RR (CI) | RR (CI) |
| **Lateral approach**     |       |       |       | b |       | b |         |         |
| Limping                  | 1,023 | 932 (91) | 91 (9) |              |  |  |  |  |
| None                     | 702 (70) | 678 (96) | 24 (4) | 1 | 1 |  |  |  |
| Slight                   | 206 (20) | 180 (87) | 26 (13) | 3.7 (2.2–6.3) | 3.5 (2.1–6.0) |  |  |  |
| Moderate/severe          | 115 (10) | 74 (64) | 41 (36) | 10 (6.6–17) | 10 (6.3–16) |  |  |  |
| **Anterior approach**    |       |       |       | b |       | b |         |         |
| Limping                  | 234 | 212 (91) | 22 (9) |              |  |  |  |  |
| None                     | 177 (75) | 166 (96) | 11 (4) | 1 | 1 |  |  |  |
| Slight                   | 45 (19) | 39 (87) | 6 (13) | 2.2 (0.84–5.5) | 2.7 (1.1–6.7) |  |  |  |
| Moderate/severe          | 12 (6) | 7 (58) | 5 (42) | 6.7 (2.8–16) | 11 (5.1–25) |  |  |  |

**RR** = Risk ratio; **CI** = 95% confidence intervals

\(a\) Column percentages.

\(b\) Row percentages.

\(c\) Adjusted for age, sex, BMI.