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## Article

# Cohort-Based Evaluation of the Risk of Low Back Pain After Total Hip Arthroplasty: A Long-Term Study

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**Abstract:** Low back pain (LBP) is a potential complication after total hip arthroplasty (THA). However, some studies suggest that THA not only alleviates joint pain but also resolves LBP in up to 88.2% of patients. Most of these observations are limited to short-term follow-up. This study investigates the long-term relationship between THA and LBP, challenging the notion that THA resolves LBP. A retrospective review was conducted on 236 patients who underwent THA (2010–2020). Multiple statistical models were applied, including unadjusted unmatched, adjusted unmatched, adjusted matched, and target trial emulation with 7887 subjects, to evaluate LBP incidence. Of the 236 patients, 119 developed postoperative LBP. The unadjusted unmatched analysis showed a relative risk (RR) of 2.23(95%CI:1.5–3.2). Adjusting for age, sex, BMI, and recruitment period reduced the RR to 1.64(95%CI:1.0–2.6). Adjusted matched analysis showed an RR of 1.09(95%CI:0.4–3.0), while the target trial emulation simulated an RR of 1.03(95%CI:0.7–1.8), indicating no significant differences. Despite an apparent initial association, adjusted analyses do not support a significant long-term relationship between THA and LBP. No reduction in postoperative LBP incidence was observed, suggesting THA is safe regarding LBP risk but lacks a curative effect. Rigorous confounding adjustment is essential in retrospective studies.

**Keywords:** hip osteoarthritis; total hip arthroplasty; low back pain; postoperative complications; long term effects; cohort analyses

## 1. Introduction

Hip osteoarthritis (HOA) is a chronic degenerative condition that causes pain, stiffness, and limited mobility in both the hip and lumbar regions, being one of the leading causes of disability in adults. The prevalence is estimated between 8% and 10.4% in the general population [1,2], with geographical variations and a marked increase with age [3–5]. THA has been established as the most effective surgical treatment to relieve pain and restore function in patients with advanced HOA [6].

Despite the clear benefits of THA, this surgical procedure is associated with potential complications [7]. Consequently, some patients develop postoperative LBP, which can significantly challenge the recovery process [8]. This complication can generate significant disability, negatively impacting quality of life. Although the biomechanical connection between the hip and lumbar spine is well documented, the factors contributing to the development of LBP after surgery continue to be the subject of study.

The incidence of LBP associated with untreated HOA has been reported between 21.2% and 100% [9,10]. Recent studies, such as that by Vigdorshik et al., have suggested that THA can alleviate LBP in up to 82% of patients with HOA within two years of follow-up [11]. However, there is a possibility that THA may generate biomechanical changes in the lumbar spine, accelerating disc degeneration and contributing to the appearance of new episodes of LBP in the long term [12,13].

Given the limited evidence on the long-term impact of THA on the development of LBP, further investigation with rigorous methodology is warranted. This study hypothesizes that THA in patients with OA will be associated with an increased risk of developing long-term LBP. The primary objective of this study is to determine the long-term impact of THA on the incidence of LBP in patients with and without pre-existing LBP, while controlling for potential confounding factors.

2. Materials and Methods

Study Design

A cohort study was conducted in patients diagnosed with HOA who underwent THA. Each patient was divided into two periods: 1) prior to THA (unexposed) and 2) after THA (exposed).

Participants and Follow-Up

The study included all patients who underwent THA at the University Clinical Hospital Lozano Blesa in Zaragoza between January 1, 2010 and December 31, 2020, aged between 18 and 72 years at the time of the intervention. The complete eligibility criteria are detailed in Table 1.

Table 1. Inclusion criteria, partial exclusion criteria and absolute exclusion criteria.

Inclusion Criteria	
- Age 18-72 years at the time of intervention	
- THA performed between 2010-2020	
Absolute Exclusion Criteria	
- Previous lower limb or axial fracture	- Avascular necrosis of the femoral head.
- THA due to fractures.	- Legg-Calvé-Perthes disease.
- Lower limb amputations.	- Hip dysplasias.
- Revision THA surgeries.	- Congenital skeletal abnormalities.
- Inflammatory diseases.	- Vertebral surgery prior to THA.
- Neurodegenerative diseases.	- Scoliosis.
- Mental illness.	- Scheuermann’s disease.
- Patients whose Electronic Medical Record only contains the surgical report.	- Neoplasms affecting the axial skeleton.
	- Bone or prosthetic infections.
Partial Exclusion Criteria	
- Bilateral total hip prosthesis.	- Previous knee arthroscopy.
- Chronic alcoholism.	- Posterior knee replacement.
- Cervical surgery.	- Post-THA leg length discrepancy.
Other Exclusion Criteria	
- Insufficient data on covariates.	
- Presence of low back pain prior to a diagnosis of coxarthrosis.	

In the preoperative THA group, the start of follow-up was established at the time of diagnosis of HOA. Follow-up was extended until the occurrence of the first episode of LBP, the THA intervention or 5 years, whichever occurred first. In the postoperative THA group, follow-up began on the date of the intervention and continued until the occurrence of the first episode of LBP, the end of follow-up or 5 years, whichever occurred first.

### *Variables and Data Sources*

The exposure variable was considered to be the preoperative THA or postoperative THA group. The outcome variables were the occurrence of LBP within 5 years of the start of follow-up and the time until its occurrence. To control for confounding, information on age, sex, height, and weight at the time of surgery was collected. All information was extracted from the Electronic Medical Records of the Aragon Health Service.

### *Data Analysis*

Several proportional hazards models were fitted, all of which considered the exposure group as the independent variable and time to the first episode of LBP as the dependent variable. First, an unadjusted model was created, followed by a model adjusted for age, sex, body mass index (BMI), and the period of follow-up initiation. Finally, a model for paired data was used, pairing the preoperative THA and postoperative THA periods for each patient and adjusting for age at the start of follow-up for each period. Hazard Ratios (HR) and 95% confidence intervals were calculated.

### *Sensitivity Analysis*

To assess the potential existence of selection or confounding biases, two additional sensitivity analyses were performed. First, the analysis was conducted with a smaller restricted sample, applying only the absolute exclusion criteria. Second, a target trial emulation study design was implemented. This type of design has been described in other articles [14]. This approach first involves specifying the protocol of a hypothetical target trial and then emulating the trial as faithfully as possible using observational data.

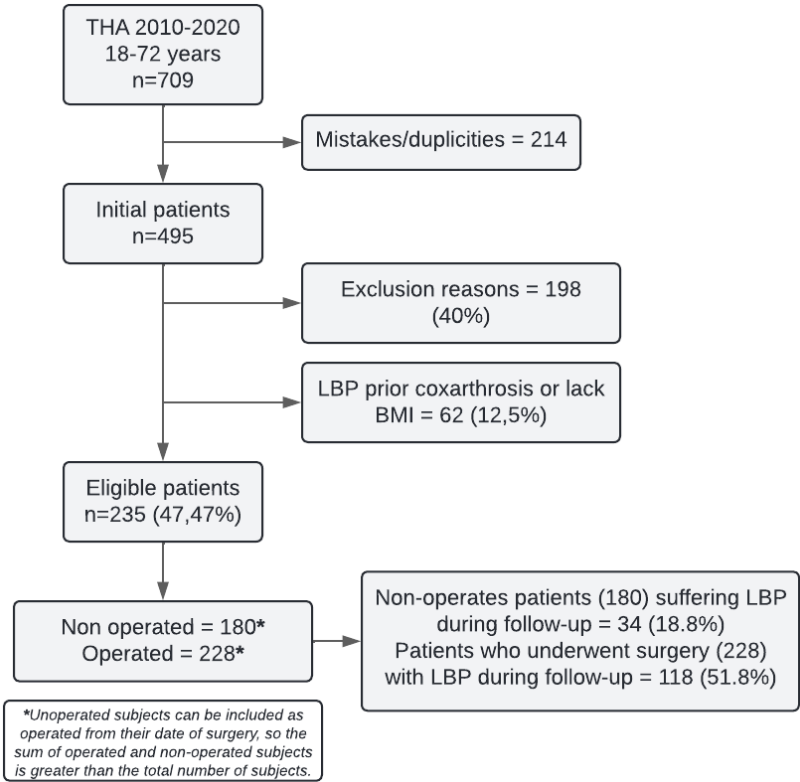
The selection criteria for the hypothetical trial were: 1) diagnosed with HOA, 2) not previously undergone THA prior to the start of the trial, 3) not have developed LBP between diagnosis and the start of the trial, and 4) not meet any of the exclusion criteria in Table 1. At the start of the trial, subjects were assigned to one of two groups: 1) not intervened and 2) THA-intervened, based on whether they underwent the surgery during the month of trial initiation. Subsequently, subjects were followed until they developed a first episode of LBP, 5 years passed, the end of the study follow-up was reached, or, in the case of the non-intervened group, they underwent THA, whichever occurred first. Finally, through combined logistic regression analysis, the incidence of LBP in the 5 years following the start of the study was modeled. In our case, this hypothetical trial was emulated with the available data and replicated 132 times, considering as the start date each month between January 1, 2010 and December 31, 2020. All analyses were performed using R software.

### *Ethical Aspects*

This study was approved by the Ethics Committee for Research of the Autonomous Community of Aragon with the code C.P.-C.I.-PI21/346 and registered in the ClinicalTrials.gov database with the identifier NCT05647629. Authorization was obtained from the hospital's medical director to conduct this study.

## **3. Results**

495 subjects diagnosed with HOA and undergoing THA were identified at the hospital during the 2010-2020 period. After applying exclusion criteria, 198 patients were excluded. Additionally, 62 more patients were excluded due to LBP prior to the diagnosis of coxarthrosis or lack of BMI data, leaving a total of 235 eligible patients for the study. 180 patients were included in the preoperative THA group and 228 in the postoperative THA group (Figure 1).



**Figure 1.** Flow chart of patients included in the study.

Of the subjects included in the preoperative THA group, 34 experienced an episode of LBP during a median follow-up of 35 months (*IQR*: 15-72). In the postoperative THA group, 118 patients experienced an episode of LBP during a median follow-up of 51 months (*IQR*: 30-83). From the preoperative THA group, 173 subjects were subsequently operated on and were also included in the postoperative THA group.

*Baseline Characteristics and Initial Follow-Up Period*

The proportion of men and women is similar in both groups, with a slight difference in median age. BMI was constant between the two groups, with an average value of 29 (*IQR* 26-32) (Table 2). The first records obtained date from 2001 to the last ones from 2022, over a 21-year period, with the greatest pre-surgical follow-up accumulating between 2006 and 2015 and the post-surgical group between 2011 and 2020 (Table 2).

**Table 2.** Baseline characteristics and standarized differences (SMD) among individuals included in the study. (BMI=Body Mass Index; *IQR*=interquantile range; SMD=standardized mean difference).

Characteristics	Pre-surgery (N = 180)	Post-surgery (N = 228)	SMD
Sex			0.04
Male	115 (64%)	141 (62%)	
Female	65 (36%)	87 (38%)	
Median age, in years ( <i>IQR</i> )	57 (52-63)	61 (55-67)	0.46
BMI, in Kg/cm^2 ( <i>IQR</i> )	29 (26-32)	29 (26-32)	0.01
Median Disease Progression, in months ( <i>IQR</i> )	0 (0-0)	25 (3-66)	1.35
Follow-up Start Period			1.18
2001-2005	14 (7.8%)	0 (0%)	

2006-2010	64 (36%)	11 (4.8%)
2011-2015	81 (45%)	112 (47%)
2016-2020	21 (12%)	105 (46%)

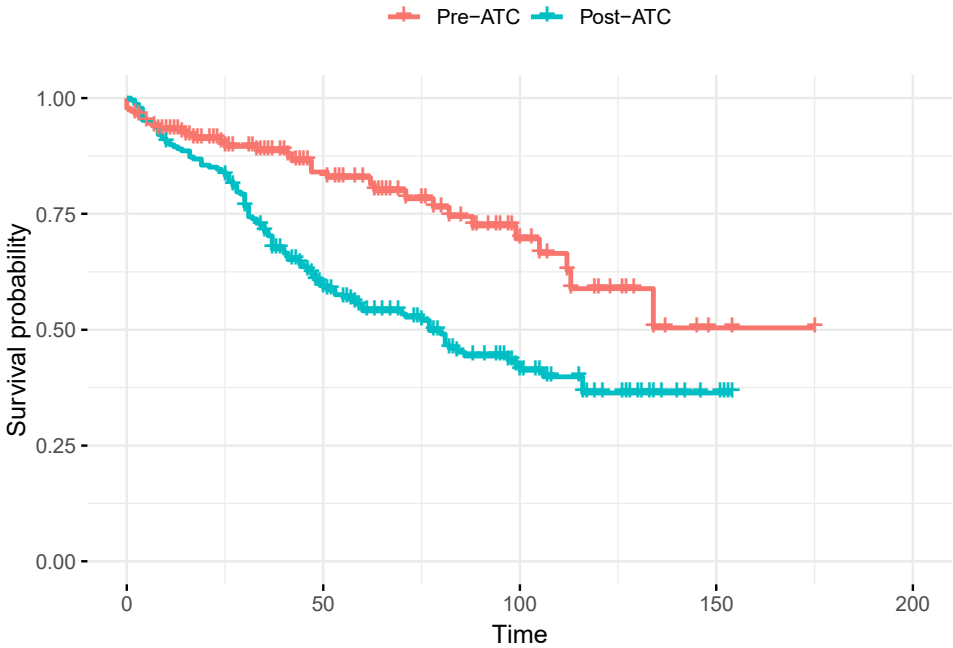
Survival Function and HR of LBP During 5 Years of Follow-Up

Table 3 presents the HRs for the development of LBP after 5 years of follow-up across the different analysis models. The unadjusted model estimated an HR of 2.2 (95%CI 1.5-3.2) for patients in the post-THA period compared to the preoperative THA period, with their survival function over time shown in Figure 2. However, after adjusting for age, sex, BMI, and the period of study inclusion, the HR decreased to 1.6 (95%CI 1.0-2.6). In the matched and age-adjusted analysis, the HR was further reduced, showing a value of 1.1 (95%CI 0.4-3.0).

Table 3. Estimated HR and Risk Ratio after 5 years of follow-up in individuals included in the study.

Model	Hazard Ratio (95% CI)		Risk Ratio after 5 years of follow-up (95% CI)	
	Pre-ATC (reference)	Post-ATC	Pre-ATC (reference)	Post-ATC
Unadjusted, n = 408	1	2.23 (1.5-3.2)		
Adjusted for age, sex, BMI and period n = 408	1	1.64 (1.0-2.6)		
Paired and adjusted for age n = 346	1	1.12 (0.4-3.1)		
Paired and adjusted for age n = 492*	1	0.77 (0.3-1.8)		
Target trial emulation**, n = 7887 person-trials			1	1.04 (0.7-1.8)

\* Only absolute exclusion criteria were applied in this analysis. \*\* Adjusted for age, sex, BMI, disease progression and period.





**Figure 2.** Kaplan-Meier survival curves of LBP incidence in non-intervened subjects with OA (pre-THA) compared to intervened subjects with LBP (post-THA).

#### *Sensitivity Analysis*

Replicating the matched analysis and excluding only subjects with absolute exclusion criteria, an LBP HR of 0.8 (95%CI 0.3-1.8) was estimated for the postoperative THA period compared to the preoperative THA period. This suggests that matching and adjusting for age can balance the baseline differences between the groups. Finally, the approach using target trial emulation, which adjusts for age, sex, BMI, disease progression time, and the period of study inclusion, estimated a RR of 1.04 (95%CI 0.7-1.8).

## **4. Discussion**

Previous studies have reported a prevalence of LBP around 49.4% and a recovery rate of 88.2% after THA with a two-year follow-up [8,11]. However, this short-term follow-up period may not fully capture the prolonged impact of muscle atrophy on lumbar biomechanics, underscoring the need for further long-term investigations.

The initial hypothesis of this study was based on the potential long-term biomechanical alterations that may arise due to damage and weakness of the psoas muscle following THA [8,12,15,16]. This powerful, bilateral muscle plays a crucial role in lumbopelvic biomechanical control and stability. Unilateral damage could result in an asymmetric balance of tensile forces at its dorsolumbar origin (T12 to L4), leading to facet joint overload in the lumbar structures and progressive long-term damage.

Eligibility criteria were defined to ensure reliable long-term outcomes. Age was limited to 18-72 years to reduce loss to follow-up due to natural causes. Patients with previous lower extremity fractures were excluded to avoid confounding orthopedic factors, and those with significant mental impairments were excluded due to potential difficulties with follow-up. These measures aimed to identify patients with OA without other comorbidities and strengthen the internal validity of the study.

Our sample revealed a similar distribution between men and women (64-62% and 36-38% respectively) and an average BMI of 29, ensuring baseline comparability between groups. In the unadjusted analysis, the occurrence of postoperative LBP had a median duration of 25 months (IQR: 3-66, SD 1.35), suggesting an earlier manifestation in the surgical group, possibly due to medium-to-long-term psoas atrophy (Table 2 and Figure 2). This temporal finding indicates that the onset of LBP after THA may not be immediate, but rather develop over a variable time interval [12,17], with a greater dispersion after the initial 25 months, the time required for the atrophied psoas to cause biomechanical problems in the lumbar spine.

Initially, our unadjusted analyses revealed a higher incidence of LBP in THA patients, with an HR of 2.23 (95%CI: 1.5-3.2). However, when adjusting for relevant confounding variables such as age, sex, BMI, and recruitment period, this association attenuated to an HR of 1.64 (95%CI: 1.0-2.6). Subsequently, in a matched adjusted analysis, where we compared each patient in the preoperative and post-surgical periods, the HR decreased to 1.09 (95%CI: 0.4-3.0), indicating that THA alone does not increase the risk of LBP. These results are consistent with those obtained through target-trial emulation, where we calculated the 5-year RR as 1.03 (95%CI: 0.7-1.8), suggesting that there are no differences in the long-term risk of LBP between patients who underwent the intervention and those who did not.

“Target-trial emulation” is an advanced epidemiological technique that aims to replicate the conditions of a randomized clinical trial using observational data [18]. This approach is particularly valuable when conducting a clinical trial is infeasible due to economic, ethical, or logistical reasons [19]. However, it is important to note that, like other observational studies, target-trial emulation cannot fully control for unknown or unmeasured confounding factors, which may impact the validity of the obtained results [20].

Despite the initial findings suggesting an association between THA and LBP, a rigorous multivariable analysis revealed that this relationship is primarily due to confounding factors. The simulation of a clinical trial supported these results, indicating that surgery cannot be considered either protective or causative of subsequent LBP. This study, with its retrospective design, methodological rigor, and extensive follow-up, underscores the importance of controlling for confounding variables in the evaluation of complex data. The results obtained contribute to a better understanding of the risk profile associated with THA.

Previous investigations, such as that conducted by Vigdorchik et al., have reported postoperative improvements [11]. However, our study suggests that the risk of developing LBP is similar among patients diagnosed with HOA, regardless of whether they receive surgical treatment. Therefore, THA cannot be considered an intervention that improves LBP in addition to hip pain. These findings are consistent with research indicating that muscle atrophy may result from disuse, not only of the psoas muscle [12], but also from the weakness of other muscles involved in hip control [21,22]. Furthermore, these results tend to be consistent, regardless of the surgical technique employed [23].

Our findings support the evidence suggesting that THA does not increase the incidence of postoperative LBP, but it is also not a technique that definitively solves this problem. Therefore, it should not be promoted as a definitive solution. It is essential that patients be properly informed that surgery does not guarantee the complete disappearance of their symptoms. A multidisciplinary approach, including physical therapy, exercise, nutritional advice, and in certain cases, pharmacological treatments, may be necessary for the optimal and effective management of LBP.

## 5. Conclusions

This study found no conclusive evidence to support an increased risk of LBP following THA. Employing advanced epidemiological analysis techniques, we estimated a 5-year RR of 1.03 for the development of LBP in patients undergoing THA, indicating that the surgery neither substantially increases nor decreases the long-term risk of LBP compared to those who did not undergo surgical intervention. The initial association observed was not statistically significant after adjusting for key confounder such as age, sex, BMI, and disease progression time.

These findings do not support the hypothesis that THA increases the long-term risk of postoperative LBP, but they also contradict previous hypotheses suggesting that THA could resolve pre-existing LBP. This study highlights the importance of considering demographic and clinical factors when evaluating the risks associated with THA, providing a more solid basis for making informed clinical decisions.

A critical appraisal of this study must consider its limitations, particularly the potential for confounding bias introduced by its retrospective design. Additional studies, preferably with prospective and controlled designs, are needed to confirm and expand these findings, as well as to explore more deeply the underlying factors that could influence the relationship between THA and long-term LBP.

In summary, this study offers a critical perspective on the relationship between THA and the occurrence of postoperative LBP, underscoring the need for continued research to improve the quality of life for patients and optimize clinical outcomes in those undergoing this intervention.

**Author Contributions:** Conceptualization, F.J.G.P. and E.M.G.T.; methodology, F.J.G.P., S.B.R.H., and E.M.G.T.; data collection, F.J.G.P. and S.B.R.H.; data curation, A.C.P.; formal analysis, A.C.P.; writing—original draft preparation, F.J.G.P., S.B.R.H., A.C.P., and E.M.G.T.; writing—review and editing, F.J.G.P., S.B.R.H., A.C.P., and E.M.G.T.; supervision, A.C.P. and E.M.G.T.; project administration, F.J.G.P. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee for Research of the Community of Aragon (CEICA) with the protocol code C.P.-C.I.-PI21/346 and registered in the ClinicalTrials.gov database with the identifier NCT05647629. Authorization to conduct the study was also obtained from the Medical Director of the Lozano Blesa Clinical Hospital in Zaragoza, Spain.

**Informed Consent Statement:** This study has a confidentiality agreement and a specific purpose for research studies approved by the Medical Director of the Lozano Blesa Clinical Hospital in Zaragoza, Spain.

**Data Availability Statement:** The data supporting the findings of this study are available from the corresponding author upon reasonable request. Data are not publicly available due to privacy restrictions and agreements with the hospital from which they were obtained.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## Abbreviations

The following abbreviations are used in this manuscript:

HOA	Hip osteoarthritis
THA	Total hip arthroplasty
LBP	Low back pain
BMI	Body mass index
HR	Hazard ratio

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