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Original article

Long-term survival analysis of low back pain onset in patients undergoing hip prosthesis surgery: a Kaplan–Meier study

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ABSTRACT

Introduction: Total hip arthroplasty has been associated with the onset of low back pain, which can significantly impact patients' quality of life. However, a detailed evaluation of the time until the onset of long-term low back pain following total hip arthroplasty remains largely unknown. This study aimed to explore the relationship between total hip arthroplasty and the development of long-term lower back pain. Through survival analysis, we examined the time of onset of low back pain in a cohort of patients who underwent the procedure, providing a detailed temporal perspective of this postoperative complication.
Hypothesis: The onset of low back pain in patients undergoing total hip arthroplasty tends to manifest in the medium and long term.
Materials and methods: A survival study using the Kaplan–Meier method was conducted on 299 patients who underwent total hip arthroplasty between 2010 and 2020 at the Hospital Clínico Universitario Lozano Blesa in Zaragoza. The event of interest was the occurrence of low back pain during monthly follow-ups, which was subsequently stratified by sex and body mass index (BMI). Death and the end of the study follow-up were considered as censored data.
Results: The sample comprised 67.6% men and 32.4% women. Additionally, 68.2% of patients were overweight or had grade 1 obesity. During the follow-up of the entire sample, 96 patients developed low back pain, with 28 cases occurring within the first 2 years. The 50% survival of the population without low back pain was established at 39 months, with a mean follow-up of 112.25 months (95% CI 105.87–118.62). Significant differences were observed in the onset of lower back pain in men when considering different BMI grades. However, no significant differences were found between sexes or among different BMI groups when gender was not taken into account.
Discussion: The results of this study provide valuable information on the survival of patients undergoing total hip arthroplasty who experienced low back pain over an extensive follow-up period. These findings have significant implications for clinical practice, indicating that patients undergoing total hip arthroplasty should be informed of this potential risk.
Level of evidence: IV; retrospective case series study.

1. Introduction

Hip osteoarthritis (OA) is a chronic degenerative condition that causes pain, limited mobility, and significantly impacts the quality of life of adults [1]. This osteoarticular dysfunction has led to total hip arthroplasty (THA) as the leading intervention to alleviate pain and improve function [2,3]. This scenario becomes even more relevant in the current demographic context, where coxarthrosis has gained prevalence due to the aging population [4]. Despite the clear benefits of THA for pain relief and functional improvement in patients with OA, there is also

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concern regarding the potential occurrence of postoperative low back pain (LBP). This phenomenon, posing an additional challenge, underscores the need to thoroughly explore the relationship between THA and LBP over a extended time horizon.

While the literature has emphasized the biomechanical connection between the hip and lumbar spine [5–8], the understanding of factors contributing to post-THA LBP remains under development [9]. In this regard, the injury to the psoas muscle during the surgical process is proposed as a possible cause associated with this complication [10]. This phenomenon can lead disability and affect quality of life, raising questions about how THA surgery influences lumbar biomechanics and contributes to long-term back pain. Several authors have suggested that THA surgery resolves the coexistence of LBP with the pain caused by hip osteoarthritis; however, these investigations are often limited to short-term follow-ups, ranging between 12 and 24 months [11–14]. In contrast, considering the influence of the psoas muscle in this context and the medium- to long-term consequences it implies [15], we argue that comprehensive evaluation of outcomes should be extended to a longer period.

This study aimed to analyze, through survival statistical tests, the timing of LBP onset in patients undergoing THA surgery. Given the lack of knowledge regarding long-term follow-up and the timing of post-operative LBP onset, the need for research shedding light on these aspects is justified. Using a descriptive retrospective approach, this study aims to estimate long-term survival and analyze risk factors associated with this event in THA patients. This longitudinal investigation will help us understand the impact of long-term LBP, enabling the development of strategies for its prevention and treatment. We hypothesized that the onset of LBP in patients who have undergone THA tends to occur in the medium to long term.

2. Material and methods

This manuscript presents a retrospective, longitudinal, observational survival study. The study was approved by the Ethics Committee for Clinical Research of the Autonomous Community of Aragón (CEICA) under the code CP-CI-PI21/346 and registered in the *ClinicalTrial.gov* database with identifier NCT05647629. This study was conducted and reported in accordance with the STROBE statement.

The medical records of all patients who underwent THA at Hospital Clínico Lozano Blesa in Zaragoza between 2010 and 2020 were requested, with ages ranging between 18 and 72 years old at the time of surgery. Initially, 709 entries were obtained. After filtering cases by removing errors, duplicates, and strict exclusion criteria (Table 1), 410 patients were excluded, leaving a final sample of 299 patients.

Information was collected on age, body mass index (BMI), clinical data on prior OA, surgery date, surgical approaches, implants used, and the onset of LBP after surgery. These data were gathered from electronic medical records, including diagnoses made by specialists in Orthopedic Surgery and Traumatology, as well as by Primary Care physicians. Both consultation records and detailed clinical notes, which provided a qualitative description of the pain and its progression, were considered. Data validity was ensured through a thorough review of medical histories, prioritizing consistency and accuracy in symptom documentation by healthcare professionals.

To examine the categorical variables, frequencies and percentages were calculated. Survival analysis, focusing on the timing of LBP onset, was conducted using a Life Table and Kaplan–Meier Curves, which included medians, percentiles, standard errors, and confidence intervals. The follow-up time was recorded in months for all studies. Survival Functions with month-by-month follow-up and overall Cumulative Survival, segmented by sex and BMI, were generated. In the survival analysis with multiple factors, Log Rank calculations with *Chi*-Squared were applied, with statistical significance set at $P < 0.05$. All evaluations were performed using IBM SPSS Statistics version 29.

This rigorous methodological approach provides a solid foundation for identifying factors associated with the onset of subsequent LBP.

3. Results

In this retrospective study, a total of 299 patients who underwent THA were examined, with an average follow-up period of 7 years. The mean age of the patients at the time of surgery was 59.91 ± 8.2 years, and the group comprised 67.5% being men (n = 202) and 32.4% women (n = 97). Folloring the surgical intervention, 32.1% of the patients developed LBP, and a 6.4% mortality rate due to unrelated causes was recorded. Regarding BMI, 18.6% of the patients were in the normal weight category, 36.4% were overweight, and 31.8% had type 1 obesity. The surgical procedure was performed in 60.5% of the cases for grade 3 OA, whereas 26.4% presented with grade 2 OA on the Tönnis scale.

The analysis of the laterality of the surgeries revealed that 164 right hip prostheses (54.8%) and 135 left hip prostheses (45.2%) were performed. The most common type of implant was SL-plus + Epfit™, accounting for 29.3% of the total, folloed by SL-Plus + Müller™ (27.0%) and Linea-Dynacup™ (9.8%.)

The Life Table analysis indicated a median survival time of 39.33 months for the onset of LBP in patients who underwent THA. During the first year after surgery, 79% of patients did not develop LBP (Table 2). The probability density for developing LBP was 1.7% per month in the first year, 0.7% in the second year, 1.3% in the third year, and 1.6% in the fourth year, showing a significant decrease over time (10th column Table 2).

The initial analysis using the Kaplan–Meier Curve was conducted with entire sample of 299 patients, resulting in 96 events and 203 censored data points. The mean follow-up was 112.25 months (95%*CI* 105.87–118.62), and at the conclusion of the study, 60% of the population reached the end of follow-up without experiencing LBP or succumbing to mortality (Fig. 1). However, when focusing solely on the 32.1% of patients who developed the condition, a survival rate of 50% was observed at 39 months (95%*CI* 33.23–44.76). Within this subset, 25% of patients developed back pain 19 months after hip surgery, whereas 75% were estimated to have experienced back pain 68 months

Table 1
Inclusion and exclusion criteria.

Inclusion criteria:	
- Age 18−72 years at the time of the intervention	
- THA between 2010−2020	
Exclusion criteria:	
- Previous low back pain before THA.	- Legg-Calvé-Perthes disease.
- Previous lower limb or axial fracture.	- Hip dysplasias.
- THA secondary to fracture.	- Congenital skeletal abnormalities.
- Lower limb amputations.	- Previous skeletal abnormalities.
- Revision THA.	- Previous spinal surgery to THA.
- Inflammatory diseases.	- Scoliosis.
- Mental illness.	- Scheuermann's disease.
- Patients whose Electronic Healt record contains only the surgical report.	- Neoplasms affecting axial skeleton.
- Femoral head avascular necrosis.	- Bone or prosthesis infections.

Table 2
Survival Life Table segregated every 12 months of follow-up.

Life Table[a]											
Interval Start Time	Number Entering Interval	Number Withdrawing during Interval	Number Exposed to Risk	Number of Terminal Events	Proportion Terminating	Proportion Surviving	Cumulative Proportion Surviving at End Interval	Std. Error Cumulative Proportion Surviving at End of Interval	Probability Density	Std. Error Probability Density	Hazard Rate	Std. Error Hazard Rate
0	96	0	96.000	20	.21	.79	.79	.04	.017	.003	.02	.00
12	76	0	76.000	8	.11	.89	.71	.05	.007	.002	.01	.00
24	68	0	68.000	15	.22	.78	.55	.05	.013	.003	.02	.01
36	53	0	53.000	18	.34	.66	.36	.05	.016	.003	.03	.01
48	35	0	35.000	7	.20	.80	.29	.05	.006	.002	.02	.01
60	28	0	28.000	7	.25	.75	.22	.04	.006	.002	.02	.01
72	21	0	21.000	11	.52	.48	.10	.03	.010	.003	.06	.02
84	10	0	10.000	2	.20	.80	.08	.03	.002	.001	.02	.01
96	8	0	8.000	6	.75	.25	.02	.01	.005	.002	.10	.03
108	2	0	2.000	0	.00	1.00	.02	.01	.000	.000	.00	.00
120	2	0	2.000	2	1.00	.00	.00	.00	.002	.001	.17	.00

[a] The median survival time is 39.33.

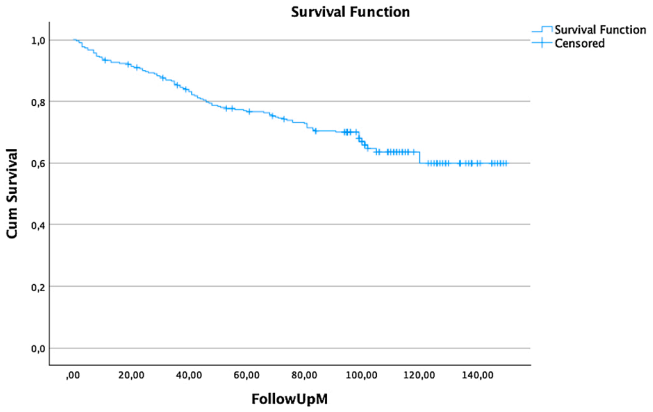

Fig. 1. Survival function with events and censored data.

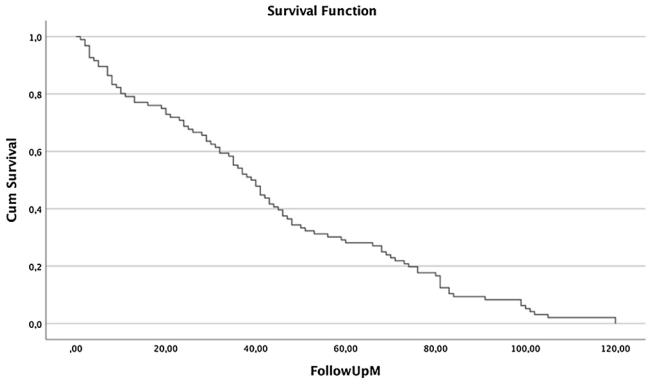

Fig. 2. Survival function with events.

after the procedure (Fig. 2).

The subsequent analysis was conducted based of gender, with 202 men and 97 women included. Among the male group, 60 patients experienced LBP, while 36 women experienced the condition. The average follow-up period was 114.86 months (95%*CI* 107.15–122.65) for man and 106.07 months (95%*CI* 94.97–117.16) for women (Fig. 3 above). Upon examining the median survival rate for those who debelop LBP, it was found to be 40 months (95%*CI* 33.49–46.50) for men and 36 months (95%*CI* 27.76–44.22) for women (Fig. 3 below). The overall comparison, assessed using the *Chi*-Square statistic for Log Rank, yielded a value of 1.107 and a *P*-value *of* 0.293 ($P > 0.05$), indicating no significant differences in survival between genders.

When examining survival based on BMI among patients who developed LBP, the median survival was 35 months was for the Obesity type 1 subgroup, which was lower than the other BMI categories, despite no statistically significant differences found across the BMI subgroups. The *Chi*-Square statistic for Log Rank was 1.69 with a *P*-value of 0.792 ($P > 0.05$), indicating that overall, survival did not show significant variations across BMI categories, with a global median of 40 months (95%*CI* 34,284−45,716) (Table 3 and Fig. 4).

Furthermore, when analyzing the survival of LBP onset data according to both BMI and gender, significant differences in survival were observed among men (*Chi*-Square 10.92, $P = 0.027 = P < 0.05$) (Fig. 5). Conversely, in women, no statistically significant differences were identified (*Chi*-Square 1.396, $P = 0.845$, $P > 0.05$). Thus, the differences in survival were more pronounced among the male subgroup, with a particular emphasis on the Obesity type 1 group (Fig. 6 and Table 4).

4. Discussion

This study delves into the complex relationship between THA and the

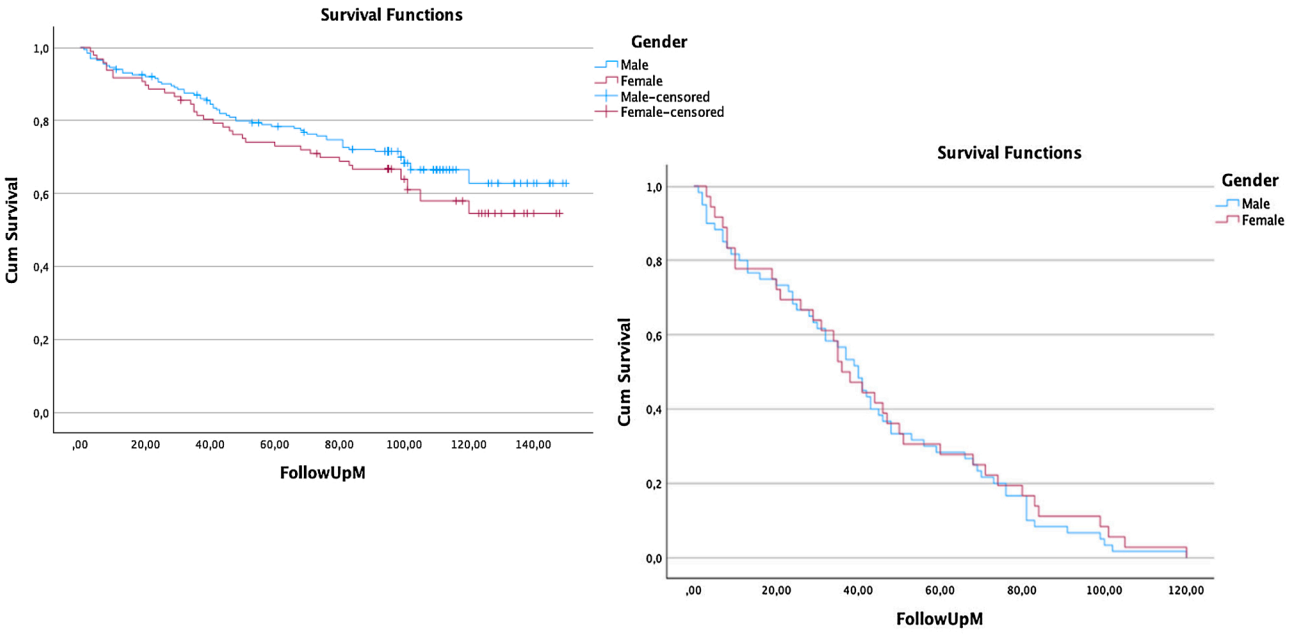

Fig. 3. Survival function with censored data (above) and with events only (below) distributed by gender.

Table 3
Means and Medians for Survival Time.

Means and Medians for Survival Time								
BMIclasif	Mean[a]				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
Normal	45.563	6.677	32.475	58.650	41.000	2.976	35.166	46.834
Overweight	46.000	5.815	34.602	57.398	40.000	5.491	29.237	50.763
Obes1	39.095	6.314	26.719	51.471	35.000	4.577	26.028	43.972
Obes2	42.429	8.286	26.188	58.669	51.000	24.877	2.241	99.759
Obes3Sever	52.600	14.875	23.445	81.755	69.000	44.913	.000	157.030
Overall	44.286	3.303	37.812	50.759	40.000	2.916	34.284	45.716

[a] Estimation is limited to the largest survival time if it is censored.

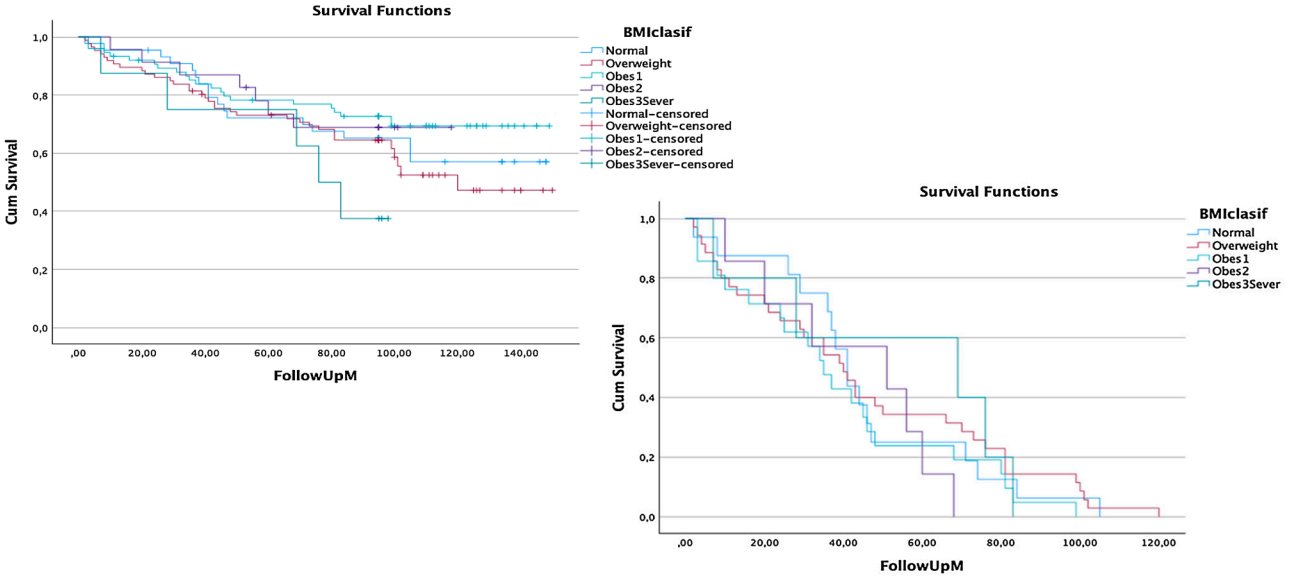

Fig. 4. Survival function with censored data (above) and with events only (below) distributed by body mass index.

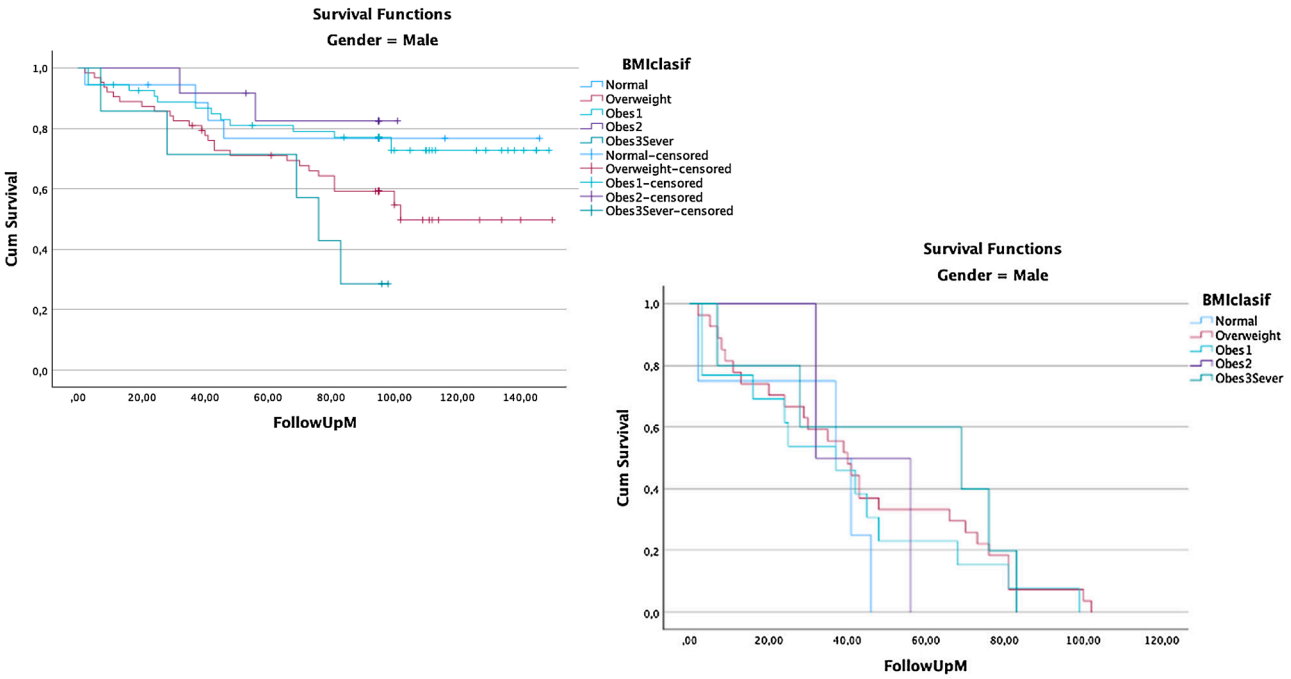

Fig. 5. Survival function with censored data (above) and only with events (below) distributed by body mass index and segregated by male gender.

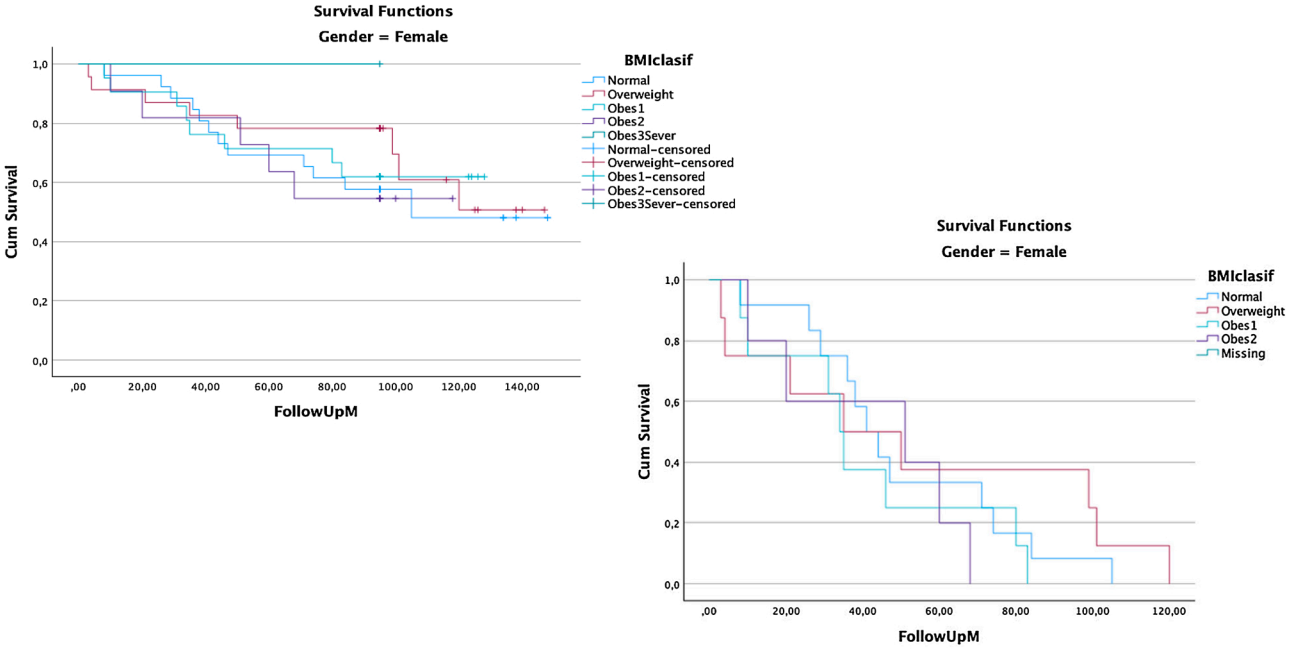

Fig. 6. Survival function with censored data (above) and only with events (below) distributed by body mass index and segregated by female gender.

onset of long-term LBP, exploring various factors and survival patterns. The results obtained through survival analysis using the Kaplan–Meier method provide a detailed perspective on the incidence of LBP in patients undergoing THA. The survival function emerges as an interesting indicator that reflects the probability of patients not experiencing the terminal event of developing LBP over time [16]. This analysis not only reveals the temporal dynamics of postoperative LBP but also contributes to the understanding of the factors and risks associated with this complication. With a rigorous scientific approach, this analysis provides a valuable tool for estimating and visualizing the probability of not developing LBP after THA, enriching our understanding of the long-term implications of this orthopedic procedure.

Demographic analysis revealed that patients undergoing the intervention had an average age of 60 years, which is the most frequently reported age [17]. In terms of gender distribution, 67.5% were men and 32.4% were women, a proportion differing from that in previous studies, where a higher prevalence of women was recorded [18]. Regarding body mass index, 36.4% of the patients were overweight, while 31.8% had grade 1 obesity, totaling 68.2%. These data indicate that more than two-thirds of patients undergoing THA were overweight or obese at the time of the procedure, which is consistent with previous studies [19–21]. This result is very different from the Japanese population studied by Kobayashi, whose estimated mean BMI was 24.6, notably lower [22].

Table 4
Means and medians for survival time between BMI and gender.

Means and Medians for Survival Time									
Gender	BMIclasif	Mean[a]				Median			
		Estimat	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound			Lower Bound	Upper Bound
Male	Normal	31.500	10.004	11.892	51.108	37.000	19.500	.000	75.220
	Overweight	43.593	5.895	32.038	55.148	40.000	5.193	29.823	50.177
	Obes1	38.000	8.458	21.422	54.578	37.000	10.785	15.862	58.138
	Obes2	44.000	12.000	20.480	67.520	32.000	.	.	.
	Obes3	52.600	14.875	23.445	81.755	69.000	44.913	.000	157.030
	Overall	42.118	4.095	34.092	50.144	40.000	3.570	33.003	46.997
Female	Normal	50.250	7.998	34.573	65.927	41.000	5.196	30.816	51.184
	Overweight	54.125	16.452	21.880	86.370	35.000	20.506	.000	75.192
	Obes1	40.875	9.951	21.372	60.378	34.000	2.828	28.456	39.544
	Obes2	41.800	11.377	19.501	64.099	51.000	33.959	.000	117.559
	Overall	47.636	5.564	36.731	58.541	41.000	6.316	28.620	53.380
Overall	Overall	44.286	3.303	37.812	50.759	40.000	2.916	34.284	45.716

[a] Estimation is limited to the largest survival time if it is censored.

Sixty-five percent of the cases were intervened due to grade 3 coxarthrosis on the Tönnis scale. However, note that the use of this scale is currently discouraged because of its lack of reliability or validity [23]. This observation underscores the critical importance of conducting thorough evaluations of measurement tools in the field of orthopedic research.

Following surgical intervention, 32.1% of patients experienced low back pain, a significantly higher proportion than the 20.11% reported by Parvizi [18]. In contrast to the partial or complete resolutions of LBP documented by authors such as Weng and Hsieh [12,13,24], our analysis suggests that LBP may emerge in the medium and long term.

The Life Table density function (Fig. 1), also known as the instantaneous risk function, is crucial for evaluating the probability of a patient developing LBP at a specific time, regardless of survival. This measure reflects the likelihood of a patient experiencing the event in question at a given time, without conditioning on their survival until that moment. Unlike the hazard function, it is not subject to patient survival. Our results indicate density functions of 1.7% per month in the first year, 0.7% in the second, 1.3% in the third, and 1.6% in the fourth, providing a meticulous description of the temporal dynamics of this complication. Importantly, this rate decreases in subsequent years, dropping to 0.6%, 0.6, 1.0, 0.2, and 0.5%, respectively. These findings offer an informed perspective on the medium to long-term evolution of postoperative LBP, highlighting a notable decrease after the first four years.

The strength of this study is reflected in the results obtained through survival analysis using the Kaplan–Meier method. With 96 events and 203 censored cases, the researchers achieved a mean follow-up of 112.25 months, which is significantly longer than most existing studies, which typically limit observations to 12–24 months [12,13,18]. This extended duration stands out as a relevant aspect, allowing the researchers to thoroughly explore the evolution of postoperative low back pain over time in patients undergoing total hip arthroplasty surgery. Specifically analyzing those patients who developed LBP, the median survival was estimated at 39 months, emphasizing the importance of using the median instead of the mean to understand the time at which approximately 50% of patients have experienced the event, in this case, LBP [25]. This approach, supported by the extended observation period, offers a more precise and meaningful perspective on the temporal dynamics of this postoperative complication.

In the follow-up analysis, which included both events and censored data according to gender, no significant differences in survival were evident, with a mean follow-up duration of 114.86 months for men and 106.07 months for women, maintaining a 50% survival rate at 40 months. On the other hand, in the body mass index analysis, although a trend of lower survival was observed in the type 1 obesity subgroup with 35 months instead of the 40 obtained, it did not reach statistical significance. These results suggest the presence of a possible confounding variable, in this case, gender. By conducting a separate or stratified analysis with this variable, it is possible to more clearly identify the corresponding differences between the groups.

The combined evaluation of gender and BMI, without considering censored data, showed a mean survival of 40 months for the onset of postoperative LBP. Given the possible confounding effect of gender, adjusted global comparisons were made, revealing statistically significant differences in men, with a Log Rank value of 10.92, $P = 0.027 = P < 0.05$. These findings indicate that both gender and BMI may influence the relationship between THA and LBP, emphasizing weight as a potential risk factor.

The fundamental strength of this study lies in its extended longitudinal follow-up, with a mean duration of 7 years, representing the longest observation period reported to date. The rigorous methodology and comprehensive scope provide valuable insights into the relationship between total hip arthroplasty and the development of postoperative low back pain. The authors' adherence to strict inclusion and exclusion criteria enhances the internal validity of the findings. However, the inherent limitations of the retrospective design must be acknowledged, including the potential for selection bias and a relatively small sample size. The retrospective nature may have also influenced data collection and the identification of causal factors.

Despite the wealth of data generated by this study, the paucity of previous research on the survival of LBP in patients undergoing THA underscores the urgent need for future research to contextualize and compare these findings. The presented results offer valuable insights into the duration and associated factors of postoperative LBP, significantly contributing to the scientific knowledge base and providing relevant information for clinical practice. The lack of comparative studies on the survival of LBP in THA patients highlights the necessity for future research to further contextualize and validate these important observations.

5. Conclusion

This study provides valuable insights into the survival time until the onset of low back pain in patients undergoing total hip arthroplasty. The results obtained through Kaplan–Meier survival analysis offer a detailed understanding of the temporal dynamics of postoperative LBP, highlighting a median survival of 39 months for those who developed the condition. These findings are in line with the initial hypothesis proposed, which suggested that the onset of LBP tends to manifest in the medium to long term. This rigorous approach and the extended follow-up duration, averaging 7 years, provide a unique and hitherto

unexplored perspective, revealing the potential risk factors associated with this complication.

Demographically, it was noted that over 68% of the operated patients were overweight or obese at the time of surgery, emphasizing the importance of considering body mass index as a potential risk factor. Furthermore, differences in survival were identified based on gender and BMI, with a more pronounced impact on men and the obesity type 1 subgroup. However, the prolonged follow-up duration and methodological meticulousness strengthen the robustness of this study, significantly contributing to the scientific knowledge and offering relevant data for clinical practice.

This analysis aims to shed light on the relationship between THA and long-term LBP while also serving as a starting point for future research in this area, highlighting the lack of comparative studies on the survival of patients with LBP after THA. Despite the inherent limitations of its retrospective approach, this study fills a gap in the scientific literature and underscores the urgent need to continue exploring the factors influencing the onset of postoperative LBP, aiming to enhance the understanding of this complication and develop effective strategies for its prevention and treatment.

CRediT authorship contribution statement

Initial Concept and Research: FJGP, EMGT.
Study Design: FJGP, EMGT.
Methodology: FJGP, SBRH, PCA, EMGT.
Data Collection: FJGP, SBRH.
Data Curation: FJGP.
Statistical Analysis: FJGP.
Project Management: FJGP.
Supervision: PCB, EMGT.
Writing: FJGP, SBRH, PCB, EMGT.

Hospital consent statement

This study has a confidentiality agreement and purpose for use for research studies, as approved by the Medical Director of the Lozano Blesa Clinical Hospital in Zaragoza, Spain.

Ethical approval statement

The study was approved by the CEICA (*Ethics Committee for Research of the Community of Aragon*) with the number C.P.-C.I.-PI21/346.

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Gemini and ChatGPT to improve the fluency and readability of the content. After using these tools, the authors reviewed and edited the text as needed and take full responsibility for the content of this publication.

Declaration of competing interest

None.

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