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Men and women undergoing total hip arthroplasty have different clinical presentations before surgery and different outcomes at 1-year follow-up

Nicolò Rossi[1] | **Alessandra Nannini**[2] | **Michele Ulivi**[1] | **Paolo Sirtori**[1] | **Giuseppe Banfi**[1] | **Rossella Tomaiuolo**[1,3] | **Laura de Girolamo**[1] | **Laura Mangiavini**[1,4] | **Giuseppe M. Peretti**[1,4]

[1]IRCCS Ospedale Galeazzi Sant'Ambrogio, Milan, Italy

[2]Residency Program in Orthopaedics and Traumatology, University of Milan, Milan, Italy

[3]Faculty of Medicine, Università Vita-Salute San Raffaele, Milano, Italy

[4]Department of Biomedical Sciences for Health, University of Milan, Milan, Italy

Correspondence
Laura de Girolamo, Orthopaedic Biotechnology Laboratory, IRCCS Ospedale Galeazzi Sant'Ambrogio, Via Cristina Belgioioso 173, Milan 20161, Italy.
Email: laura.degirolamo@grupposandonato.it

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Abstract

Purpose: The purpose of this study was to investigate the influence of sex on patients undergoing total hip arthroplasty (THA) for hip osteoarthritis (HOA), aiming to assess the clinical and functional outcomes using patient-reported outcome measures (PROMs).

Methods: A retrospective analysis of patients undergoing THA at Ospedale Galeazzi-Sant'Ambrogio between 2016 and 2022 was conducted. Inclusion criteria encompassed Kellgren–Lawrence grade III or IV HOA, with preoperative and 12-month postoperative PROMs. Enroled patients have been selected from a larger cohort without matching design for confounders. The analyses were performed using R software v4.0.3 (R Core Team) and data distributions were assessed using the Shapiro–Wilk normality test.

Results: One hundred ninety patients (72 male and 118 female) who had both preoperative and postoperative PROMs have been analysed from our institutional prosthesis registry (Datareg). Baseline and 12-month post-THA PROMs showed significant improvements overall. VAS score dropped notably from baseline to 3 months postsurgery (7.1 ± 2.1 vs. 0.9 ± 1.7). Functional and mental PROMs, including Harris Hip Score-functional (HHS-F), Harris Hip Score-total (HHS-t), SF-12PS and SF-12MS, exhibited substantial improvements post-THA. Stratifying by sex, males had lower baseline VAS, higher HHS-F, SF-12MS and hip disability and osteoarthritis outcome score-physical function short form (HOOS-PS). At 12 months, males displayed significantly better VAS, HHS-F, SF-12PS and HOOS-PS scores. Complication rates were minimal (1.5%), with stable rates across genders, mostly involving dislocation and periprosthetic fractures. Implant survival at 12 months reached an impressive 99%.

Conclusion: THA remains an effective treatment for severe HOA. However, females presented with worse baseline conditions and showed relatively less improvement at 1-year postsurgery compared to males. This difference

Abbreviations: HHS-F, Harris Hip Score-functional; HHS-T, Harris Hip Score-total; HOA, hip osteoarthritis; HOOS-PS, hip disability and osteoarthritis outcome score-physical function short form; PROM, patient-reported outcome measure; SF-12MS, 12-Item Short Form Survey Mental Scale; SF-12PS, 12-Item Short Form Survey Physical Scale; THA, total hip arthroplasty; VAS, Visual Analogue Scale.

could be attributed to physiological and psychosocial factors associated with sex, including hormonal changes, muscle mass decline and perception of pain. Longer follow-ups and prospective studies are necessary to validate these findings and facilitate personalised approaches in HOA treatment, emphasising the need for careful consideration of sex-related variables in clinical decision-making for THA patients.

Level of Evidence: Level III.

KEYWORDS

hip, osteoarthritis, sex, total hip arthroplasty, women

INTRODUCTION

Hip osteoarthritis (HOA) is a chronic musculoskeletal disorder causing pain and functional impairment of the lower limb, impacting the patient's quality of life and representing a leading cause of global disability and socioeconomic burden [8, 13, 30] with 300 million people affected by hip and knee osteoarthritis (OA).

Total hip arthroplasty (THA) is the gold standard when conservative treatments fail, as it represents the most effective surgical procedure to treat HOA. Although surgical treatment has changed the natural history of HOA with excellent long-term results [18], it is crucial to focus on the demographic variables that may influence clinical outcomes after THA [37]. Among them, sex has raised interest in a variety of musculoskeletal conditions. A retrospective analysis of a cohort of 6,123,637 patients found that males had increased rates of individual adverse events, whereas females had higher urinary tract infection rates [4]. Moreover, some authors reported higher implant failure rates after THA in men compared to women; other authors found no differences between women and men [17, 28]. A recent review showed that female patients need more specific attention in the preoperative, intraoperative and postoperative phases to improve clinical and functional outcomes and that THA outcomes may be influenced by sex- and gender-related factors [37]. These various outcomes may be due to the heterogenicity of the patients analysed with different comorbidities or other limitations, such as short follow-up. Therefore, there is a lack of clear evidence on hip replacement regarding sex differences, and the influence of sex- and gender-related factors on THA outcomes has yet to be defined.

This study aims to evaluate the impact of sex on patients affected by HOA and treated with THA, comparing the clinical and functional outcomes up to 1 year of follow-up using patient-reported outcome measures (PROMs) of the patients enroled in our institutional prosthesis registry (Datareg) of Ospedale Galeazzi-Sant'Ambrogio in Milan, Italy. We hypothesised that patient characteristics such as sex could influence the response to treatment and rehabilitation protocol, which would allow the surgeon to find a strategy personalised to the patient's characteristics.

MATERIALS AND METHODS

Patients who underwent THA at Ospedale Galeazzi-Sant'Ambrogio (former Galeazzi Orthopaedic Institute) and enroled in our institutional prosthesis registry (Datareg) between 2016 and 2022 were retrospectively analysed.
Inclusion criteria were

- Patients with disabling hip pain and functional loss with evidence of Kellgren–Lawrence grade III or IV HOA
- Availability of preoperative and postoperative (12 months) patient-reported outcome measures (PROMs)
  1. Visual Analogue Scale (VAS)
  2. 12-Item Short Form Survey Physical Scale (SF-12PS)
  3. 12-Item Short Form Survey Mental Scale (SF-12MS)
  4. Harris Hip Score-functional (HHS-F)
  5. Harris Hip Score-total (HHS-T)
  6. Hip disability and osteoarthritis outcome score-physical function short form (HOOS-PS)

Exclusion criteria were

- Previous ankle or knee replacement on the treated limb
- Patients treated with a combined bilateral approach.

Surgical technique

Between April 2016 and December 2022, two senior orthopaedic surgeons experienced in the anterior hip approach performed all surgeries. The patients were positioned on a Judet-type orthopaedic table enabling various hip movements during surgery. The incision was performed 2 cm below and 1 cm distal to the anterosuperior iliac spine, extending 6–8 cm. Special attention was paid to identifying landmarks due to the proximity of nerves. The aponeurosis of the tensor fascia lata was incised and displaced laterally with retractors, while the sartorius was displaced medially. The anterior hip capsule was then accessed, and the femoral head and neck were exposed through a partial anterior capsulectomy. The neck was cut using an oscillating saw to prevent harm to the surrounding tissues. After exposing and reaming the acetabulum, the acetabular component was placed using an impactor, orienting it at 40–45° of abduction. Following femoral rasping, the stem was implanted. Hip reduction was then performed. The wound was closed suturing the superficial aponeurosis of the tensor and the skin in two layers.

Clinical and functional analysis

During the preoperative visit, patients were evaluated clinically and enroled in the study registry. VAS, SF-12PS, SF-12MS, HHS-F, HHS-T and HOOS-PS scores were collected at baseline and at 12 months after surgery. Furthermore, data related to failure and reoperation rate were collected.

Statistical analysis

The analyses were performed using R software v4.0.3 (R Core Team). Data distributions were assessed using the Shapiro–Wilk normality test. According to the results of this test, variable differences between preoperative and postoperative have been performed using the Student *t* test or paired *t* test (for normally distributed data) or using Mann–Whitney test or paired *t* test and Wilcoxon test for paired data (for not-normally distributed data). Comparison between males and females, at the two different time points has been performed using the two-way analysis of variance to measure the possible interaction between variables. $p < 0.05$ was considered statistically significant.

RESULTS

About 5152 patients were enroled in our institutional prosthesis registry (Datareg) between 2016 and 2022 and 190 had completed preoperative and postoperative PROMs (12 months) available for analysis. Preoperative patient demographics are reported in Table 1. Among the 190 patients, 72 were male (37.89%) and 118 were female (62.11%). Demographic data did not show any statistically significant difference and were normally distributed.

TABLE 1 Main characteristics of the study population.

Patient demographic data	
Mean age	68.8 (±10.6)
Mean age by sex	
M	64.3 (±10.9)
F	71.5 (±9.6)
Mean BMI	22.9 (±10.2)
Mean BMI by sex	
M	22.6 (±10.9)
F	23.7 (±10)
Mean American Society of Anesthesiologists (ASA) class	
1.4	
Mean ASA by sex	
M	1.4
F	1.4

Abbreviation: BMI, body mass index.

Patient-reported outcome measures (PROMs) in the overall population

Overall, a significant improvement in PROMs was recorded at 1 year of follow-up compared to baseline values. PROM values at baseline and 12 months after surgery are reported in Figure 1. VAS showed a statistically significant drop between the baseline and the 3 months of follow-up (7.1 ± 2.1 vs. 0.9 ± 1.7, respectively; $p < 0.001$). Overall, the functional and quality of life PROMs showed a significant improvement (HHS-F: 28.6 ± 9 vs. 44.1 ± 5.1; $p < 0.001$, HHS-t: 52.2 ± 15.4 vs. 94.1 ± 8.1; $p < 0.001$, SF-12PS: 33.1 ± 6.8 vs. 47.8 ± 8.9; $p < 0.001$, SF-12MS: 48.7 ± 11.5 vs. 54.4 ± 8; $p < 0.001$). From a clinical point of view, HOOS-PS showed a statistically significant improvement from baseline to follow-up (46.6 ± 19 vs. 14.7 ± 14; respectively; $p < 0.001$).

Patient-reported outcome measures (PROMs) stratified by sex

PROM values at baseline and 12 months after surgery and stratified by sex are reported in Table 2 and Figure 2. Male patients showed a statistically significant difference at the baseline if compared to female patients with a lower VAS value (6.6 ± 2.1 vs. 7.4 ± 7.4; $p < 0.05$), a higher HHS-F (30.8 ± 7.7 vs. 27.2 ± 9.6; $p < 0.01$), SF-12MS (52.2 ± 10.6 vs. 46.6 ± 11.5; $p < 0.01$) and HOOS-PS (41 ± 18.8 vs. 50.0 ± 18.5; $p < 0.001$). Conversely, HHS-T and SF-12PS did not show any statistical difference at the baseline (n.s). At 12 months of follow-up, male patients showed a statistically

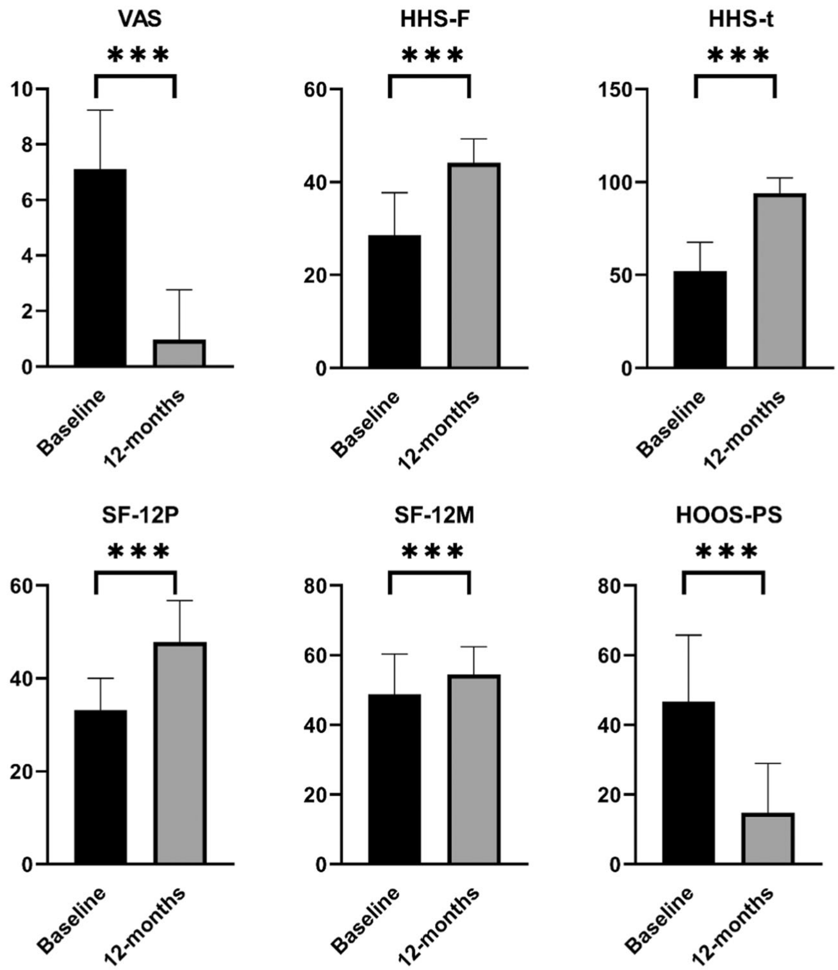

FIGURE 1 Differences in PROMS between baseline and 12 months of follow-up in the general population. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

significant difference for VAS (0.5 ± 1.2 vs. 1.2 ± 1.9; $p < 0.05$), HHS-F (45.6 ± 3.2 vs. 43.2 ± 5.7; $p < 0.05$) SF-12PS (50.9 ± 6.2 vs. 45.9 ± 9.8; $p < 0.001$) and HOOS-PS (9.0 ± 9.3 vs. 18.1 ± 15.5; $p < 0.001$) with worse parameters for female. Moreover, the combined analysis of time and sex showed that sex influenced all the variables.

Baseline PROMs in the total number of patients enroled in the registry

Baseline PROM values in the total number of patients enroled in the registry and the cohort analysed are reported in Table 3. The difference between men and women observed in the cohort available at follow-up ($n = 190$) showing poorer clinical and functional outcomes for the female population was confirmed by analysing the baseline values in the entire cohort of patients ($n = 5152$), where female patients were 3195 and male patients were 1957. No statistically significant difference was observed in terms of PROMs between the smaller cohort and the entire cohort at baseline.

Complications

In the 12-month follow-up period, only 15 patients (7.8%) had diverse orthopaedic complications, including dislocation, infection, periprosthetic fracture and miscellaneous issues. Thirteen of them required readmission, of which two underwent revision surgery during their hospital stay. Notably, postoperative periprosthetic fractures emerged as the most prevalent cause, necessitating readmission. The implant's survival rate at the 12-month follow-up, considering revision due to any cause as an endpoint, stood at 99%. In addition, based on the data collected in our registry, no significant difference in terms of complications was observed between men and women.

DISCUSSION

The main findings of this study are that, overall, THA represents an effective treatment for patients affected by severe stages of HOA when conservative management fails. Interestingly, female patients presented with

TABLE 2 Variables and differences between groups.

Sex	Baseline Mean + SD	*p* Value	12 months Mean + SD	*p* Value	Sex effect *p* Value
VAS					
M	6.6 ± 2.1	*	0.5 ± 1.2	*	<0.01
F	7.4 ± 2.4		1.2 ± 1.9		
HHS-F					
M	30.8 ± 7.7	**	45.6 ± 3.2	*	<0.001
F	27.2 ± 9.6		43.2 ± 5.7		
HHS-T					
M	54.5 ± 14.1	*ns*	96.7 ± 4.8	*ns*	<0.01
F	50.8 ± 16		92.6 ± 9.3		
SF-12PS					
M	34.1 ± 6.9	*ns*	50.9 ± 6.2	***	<0.001
F	32.5 ± 7.9		45.9 ± 9.8		
SF-12MS					
M	52.2 ± 10.6	**	56.4 ± 5.8	*ns*	<0.001
F	46.6 ± 11.5		53.1 ± 8.8		
HOOS-PS					
M	41.0 ± 18.8	***	9.0 ± 9.3	***	<0.001
F	50.0 ± 18.5		18.1 ± 15.5		

Abbreviations: HHS-F, Harris Hip Score-functional; HHS-T, Harris Hip Score-total; HOOS-PS, hip disability and osteoarthritis outcome score-physical function short form; VAS, Visual Analogue Scale.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

worse clinical conditions at baseline, resulting in overall lower clinical and functional outcomes at 1-year follow-up when compared to men. In general, surgical treatment provides great benefits in the population [32] with the annual count of THA procedures that is expected to escalate by 2030 [1].

Differently from the registries of other institutions that mainly collect data on failure rates, the institutional registry of the Ospedale Galeazzi Sant'Ambrogio collects PROMs with the aim of describing the patients' perceptions in a standardised way [22, 27]. These PROMs evaluate clinical and functional recovery, patient quality of life restoration and implant awareness [40]. Despite the high number of patients lost at follow-up in terms of PROM data in the registry, a high number of patients enroled with a baseline clinical and functional evaluation was available. In fact, the similar results in terms of clinical presentation observed at baseline between the cohort of 190 patients available at follow-up and the entire registry cohort suggest that the small cohort is representative of the larger registry population supporting the reliability of the study findings. The difference between male and female patients at baseline is well-known [38]. It has been reported that OA is not only more common in women but also with greater severity. Based on the investigations on the relationship between symptoms and radiographic grades of OA, it has been found that women often present with more severe symptoms compared to men with the same radiographic grade of OA [7].

Clinically, women above 50 years/old undergo hormonal changes, which is the primary physiological change associated with menopause [16]. The drop in oestrogen concentration may play a role in the onset of symptoms and the OA pathogenesis. It has been reported that chondrocytes present oestrogen receptors that can upregulate proteoglycan synthesis when stimulated by the hormones, which benefit the articular microenvironment [26, 29]. Therefore, the role of oestrogen in OA has raised interest. In an OA rat model, a bilateral ovariectomy and intraarticular monosodium iodoacetate injections were performed to establish a postmenopausal OA, showing the inverse proportion between the concentration of miR-203 and oestrogen receptor α (Erα). The level of miR-203 was indeed higher when the level of ERα was lower in OA knee joint cartilage [39]. In addition, intraarticular

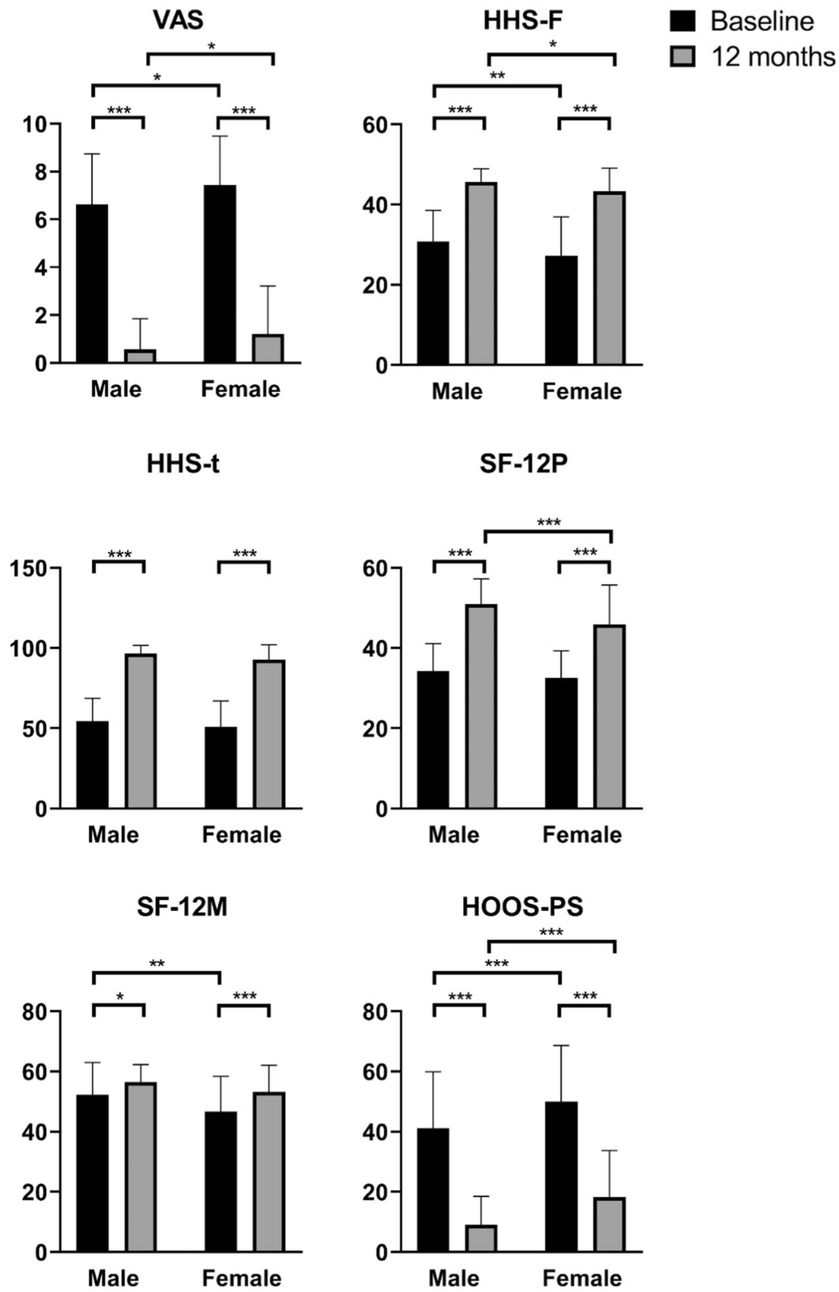

FIGURE 2 Differences in PROMS between baseline and 12 months of follow-up in the population stratified by sex. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

injection of a miR-203 inhibitor attenuated cartilage degradation by elevating ERα levels in vivo, underlying the protective role of oestrogen stimulation on cartilage health, as already reported [12].

An additional aspect that should be considered is that menopause often reduces muscle mass and strength [20]. The decline in muscle mass may align with the oestrogen decrease that characterises menopausal years [33]. The muscle loss has been reported to be mainly due to an imbalance between protein synthesis and protein catabolism [3], thus impairing muscle strength. This evidence might explain the lower function outcomes for women patients in the present study. Together with the decline in muscle mass, the older age of the female patients at the moment of the surgery may also explain the different functional outcomes between the two groups. Several studies have reported that ageing and loss of muscle mass can be detrimental to daily physical activities, such as rising from a chair, walking and recuperating after surgery or hospitalisation [5, 15, 36]. Finally, psychological and social factors could also have a role in the worse clinical presentations of women. The menopausal state can impact a patient's quality of life, in some women

TABLE 3 Variables and differences between groups at baseline.

Variables	Sex	Cohort available at follow-up (*n* = 190) Mean + SD	*p* Value	Entire cohort (*n* = 5152) Mean + SD	*p* Value
VAS	M	6.6 ± 2.1	*	6.4 ± 2	*
	F	7.4 ± 2.4		7.6 ± 2.3	
HHS-F	M	30.8 ± 7.7	**	31 ± 6.2	**
	F	27.2 ± 9.6		28 ± 8.0	
HHS-T	M	54.5 ± 14.1	*ns*	55.7 ± 14.8	*ns*
	F	50.8 ± 16		52.1 ± 14	
SF-12PS	M	34.1 ± 6.9	*ns*	33.9 ± 6.2	*ns*
	F	32.5 ± 7.9		33 ± 7.1	
SF-12MS	M	52.2 ± 10.6	**	54.4 ± 8.0	**
	F	46.6 ± 11.5		48 ± 10.8	
HOOS-PS	M	41.0 ± 18.8	***	40 ± 15	***
	F	50.0 ± 18.5		48.3 ± 18.6	

Abbreviations: HHS-F, Harris Hip Score-functional; HHS-T, Harris Hip Score-total; HOOS-PS, hip disability and osteoarthritis outcome score-physical function short form; VAS, Visual Analogue Scale.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

contributing to improved anxiety, depression and different perceptions of pain [2]. At the same time, men, who generally have more physically demanding jobs, may find the symptoms of hip OA unbearable earlier than women and, therefore, seek orthopaedic care sooner. This seems supported by the younger age of the patients in our cohort (64.3 years/old) compared with that of the women (71.5 years/old), although this difference is not significant. To date, it has been described how pain perception and expression follow a distinct pattern between men and women [24]. Women tend to be more accurate and free when describing their sensations and pain, whereas men tend to downplay and be more stoic, contributing to creating a gender bias in pain treatment [31].

Another finding of this study is that the difference between men and women at baseline is maintained after surgery, again with more unfavourable outcomes in women. To date, this data and the overall change in PROM outcomes are in line with the minimal clinically important difference reported in the literature meant as the minimum change in PROM scores that patients perceive as a significant change in their health [10, 11, 19, 35]. The relationship between poor long-term outcomes and worse baseline values has already been reported [6, 21]. In a cohort of 1120 patients over 65 who underwent THA, with 61.4% female, the functional status and pain levels were analysed after one year from surgery. The results indicated that, at follow-up, males, after adjusting for age and comorbidities, showed better walking ability and experienced less pain while walking compared to females. Males also required less assistance. Even after a year, sex-based differences persisted: females still had limited walking abilities and relied more on aid for daily activities [14]. Similarly, Patel et al. retrospectively examined 418,885 patients (59.1% females) undergoing elective THAs and TKAs from 2011 to 2017. They identified notable differences ($p < 0.01$) between genders, including higher body mass index (BMI), older age and greater preoperative need for functional support in females [25]. Our study shows that the average age and BMI among females are higher than males, with 71.5 (±9.6) versus 64.3 (±10.9) years old and 23.7 (±10) versus 22.6 (±10.9) for BMI.

A review paper highlighted that among factors contributing to a higher risk of periprosthetic fractures, female gender associated with advanced age and cementless implants stood out [34]. Moreover, a more recent study based on the Norwegian Arthroplasty Register revealed that older women receiving cementless stems faced the highest risk of revision surgery [9].

However, despite the PROMs difference between sexes, no statistically significant variations in complication rates were observed in the present study. The literature shows a lack of consistent information on this matter. In their study, Patel et al. identified female gender as an independent risk factor for readmission, reoperation and wound infections following THA. Irrespective of the procedure, females had a 64%–82% higher likelihood of needing a hospital stay exceeding two days than males [25]. Conversely, another study raises the spectre of higher overall 90-day medical complications and readmission rates in men undergoing THA, whereas women exhibited a higher occurrence of urinary tract infections, posthemorrhagic anaemia and longer hospital stays [23].

Our study has some limitations. First, this is a retrospective analysis of a cohort of patients without a control group. Prospective studies with a comparison group are, therefore, advisable to definitively prove the effect of sex on THA outcomes. However, the strength of a registry study is based on the availability of real-world data, which allows for a more reliable picture of the THA patient population. Moreover, in this study, enroled patients have been selected from a larger cohort without a matching design. In addition, our study analysed only one-time point, up to 1 year. Additional analyses with longer follow-ups are required to confirm these data to help surgeons apply a more personalised approach to patients affected by HOA. Finally, the concerning high rate of loss at follow-up in our institutional registry underlines the need to improve patients' engagement during follow-up to obtain a stronger data set to guide more reliable clinical recommendations for THA patients.

CONCLUSION

This 1-year follow-up study on a cohort of men and women treated with THA for HOA demonstrated that THA outcomes are good and stable over time, although the female gender is associated with higher severity of clinical scenarios before surgery, in turn, impacting the outcomes at follow-up. Given the increased interest and attention that modern medicine is paying to sex and gender, the results of the present study confirm the need for a more personalised approach aimed at addressing women with HOA with an earlier evaluation and treatment. In line with that, investing in a detailed and robust registry seems to be crucial for further improvements in the treatment of patients.

AUTHOR CONTRIBUTIONS

Nicolò Rossi, Laura de Girolamo, and Alessandra Nannini analysed the data and drafted the manuscript. Michele Ulivi, Paolo Sirtori, Giuseppe Banfi, Rossella Tomaiuolo, and Laura Mangiavini reviewed and edited the manuscript. Giuseppe M. Peretti reviewed the manuscript and approved its final version before submitting.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ETHICS STATEMENT

Written informed consent was obtained from the patients for publication of the present study.

ORCID

Nicolò Rossi http://orcid.org/0000-0003-4895-4789
Laura de Girolamo http://orcid.org/0000-0002-9979-3092

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