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Trends and Factors Influencing Surgical Choices for Femoral Neck Fractures

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Abstract: Introduction: Femoral neck fractures pose significant health risks, particularly in the elderly population, leading to mortality, morbidity, and decreased quality of life. Surgery is the preferred treatment to restore function and alleviate pain, with options including total hip arthroplasty (THA) and hemiarthroplasty (HA). However, clinical guidelines for selecting surgical procedures remain heterogeneous, prompting the need for further investigation into treatment trends and influencing factors. Methods: Data from the NIS database spanning 2016–2019 were analyzed, focusing on patients diagnosed with intracapsular femoral neck fractures and undergoing THA or HA as primary in-hospital surgeries. Advanced statistical analyses using SPSS and MATLAB were conducted to identify trends and factors influencing surgical choices. Results: Comorbidity profiles varied significantly between HA and THA patients, with specific conditions such as Alzheimer's disease showing higher prevalence in HA patients. Demographic differences included a higher proportion of females and Medicare-insured individuals in the HA group. Racial disparities were observed, with differences in surgical preferences among various ethnic groups. THA adoption gradually increased over the study period, indicating a shift in surgical priorities. Additionally, THA patients tended to be younger on average compared with HA patients. Conclusions: This study highlights evolving trends in surgical management for femoral neck fractures and identifies factors influencing treatment decisions in our cohort. Understanding these trends and disparities is crucial for optimizing patient care and informing future clinical guidelines. Further research should focus on assessing different surgical approaches' long-term outcomes and cost-effectiveness.

Keywords: femoral neck fracture; total hip; THA; big data

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1. Introduction

Traumatic hip fractures represent a significant growing healthcare concern, particularly in an aging population. Patients with a hip fracture are at substantial risk for death, health complications, and a negative impact on quality of life [1,2]. To restore function, reduce morbidity, and control pain levels, surgery is the treatment of choice among those capable of surgery [3]. While operative management of impacted and nondisplaced femoral neck fractures usually involves in situ fixation, operative options for displaced femoral neck fractures include closed reduction and internal fixation (CRIF) [2], open reduction and internal fixation (ORIF), HA (hemiarthroplasty), and THA (total hip arthroplasty) [4].

The popularity of total hip THA and HA as treatments for older individuals with displaced femoral neck fractures is increasing [4,5]. These procedures are essential for patients whose native hip joints cannot be preserved, particularly in cases involving severe

osteoarthritis or other significant degenerative changes. Surgical indications for THA or HA are influenced by factors such as the patient's overall health, age, and activity level, the anatomical characteristics of the fracture, and surgeon preference. For instance, THA may be favored in younger, more active patients, while HA might be preferred in frailer individuals with multiple comorbidities. Additionally, some studies suggest that THA provides better functional outcomes compared with HA in certain populations [6–8]. Some suggest that THA provides a clinically unimportant improvement over hemiarthroplasty in function and quality of life [9].

Currently, there are no universally established clinical guidelines for determining the appropriate surgical procedure for femoral neck fractures. The choice of treatment varies significantly among surgeons, with differing indications and preferences for particular modalities depending on individual patient factors and surgeon experience [4,5]. Although previous research has found that HA has become the most common treatment modality for displaced femoral neck fractures, over the last 20 years, THA as a treatment for displaced femoral neck fractures has increased [10].

Research Questions

Our study takes a unique approach by utilizing the Nationwide Inpatient Sample (NIS) database from 2016 to 2019 to observe trends in THA vs. HA for femoral neck fractures. We aimed to calculate the general treatment trend and examine what medical and non-medical factors influence treatment decisions.

2. Methods

We obtained data from the National Inpatient Sample (NIS), a key component of the Healthcare Cost and Utilization Project (HCUP), for the period from 2016 to 2019. The NIS is a comprehensive public database that captures approximately 20% of all inpatient stays across the United States, representing a broad range of hospitals and about 7 million unweighted hospitalizations annually.

For our analysis, we utilized advanced statistical tools, including SPSS Statistics (version 26) and MATLAB (R2021a). We focused on patients diagnosed with proximal femoral fractures, particularly those classified under ICD-10 codes as intracapsular femoral fractures. Our study included patients who underwent either total hip arthroplasty (THA) or hemiarthroplasty (HA) as their primary in-hospital surgical procedures. To ensure the accuracy of our cohort, we excluded patients who received fixation treatments with three screws, as these cases could introduce bias due to the presence of other injuries or medical complications.

The inclusion criteria were further refined to focus on patients aged 65 and older, in line with current clinical guidelines that generally recommend arthroplasty for this demographic. Additionally, we excluded patients with elective admissions and those who underwent surgery before hospital admission, to maintain consistency in the analysis.

Our methodology identified 57,082 unique cases from an initial pool of 27 million hospitalized patients, ultimately narrowing to a specialized cohort of 285,410 patients. This large and diverse dataset allowed us to conduct a comprehensive big data analysis, concentrating on the outcomes and trends related to THA and HA procedures.

To ensure a thorough understanding of patient comorbidities, we employed MATLAB to analyze patient-specific ICD-10 codes, ranging from ICD-10DX2 to ICD-10DX36. We cross-referenced these codes with an external database (https://www.icd10data.com/, accessed on 1 January 2024) to enhance accuracy, supplementing our automated analysis with manual validation. This process helped us identify the relevant comorbidities associated with each case.

We then used SPSS to visualize the annual trends in THA and HA procedures and performed various statistical analyses, including *t*-tests and ANOVA, to compare the two groups. Given the large sample size, we applied a stringent *p*-value threshold of less than 0.01 to identify statistically significant results.

To optimize data presentation and improve the visualization of trends and outcomes, we utilized Microsoft Excel (Version 2021) to create detailed graphical representations. These visualizations helped clarify the key statistical insights derived from the data.

Finally, this study was conducted under exempt status granted by the institutional review board, and the requirement for informed consent was waived because of the de-identified nature of the NIS dataset. This allowed us to proceed with the analysis while adhering to ethical research standards.

3. Results

As shown in Table 1, the analysis revealed distinct comorbidity profiles between hemiarthroplasty and total hip arthroplasty patients. For instance, hypertension was more prevalent in the hemiarthroplasty group (50.2% vs. 48.4%, $p = 0.000$). Alzheimer's disease was notably higher in hemiarthroplasty patients (9.2% vs. 3.3%, $p = 0.000$). However, osteoporosis showed no difference between groups (15.4% for both, $p = 1.000$). Several other conditions exhibited significant variations in prevalence, highlighting the diverse health backgrounds of the two surgical groups.

Table 1. Comorbidity differences in hemiarthroplasty vs. total hip arthroplasty patients (2016–2019).

Condition	% Hemi (Yes)	% Total (Yes)	*p*-Value
Hypertension	50.2	48.4	$p < 0.0001$
Dyslipidemia	46.3	45	$p < 0.0001$
Chronic Anemia	12.8	11.4	$p < 0.0001$
Osteoporosis	15.4	15.4	1.000
Parkinson's Disease	5.1	3.3	$p < 0.0001$
Alzheimer's Disease	9.2	3.3	$p < 0.0001$
Chronic Kidney Disease	22.7	15.8	$p < 0.0001$
Congestive Heart Failure	4.6	2.8	$p < 0.0001$
Chronic Lung Disease	16.7	12.9	$p < 0.0001$
Obstructive Sleep Apnea	3.1	4.3	$p < 0.0001$
Smoking	0.6	0.8	0.004
Alcohol Abuse	2.5	3.1	$p < 0.0001$
Type 2 Diabetes Mellitus	22	20.8	$p < 0.0001$
Fluid and Electrolyte Disorders	27.7	23.5	$p < 0.0001$
Depression	14.7	12.4	$p < 0.0001$
Valvular Disease	7	4.7	$p < 0.0001$
PeripheralVascular	4.7	3.5	0.000
Coagulopathy	1.3	1.4	0.14
Psychoses	0.1	0.03	0.000
Hypothyroidism	23	20.6	0.000
liver disease	0.6	0.5	0.1
Lymphoma	1.4	1.1	0.001

Table 2 shows that females comprised 69.7% of the hemiarthroplasty and 68.6% of the total hip arthroplasty patients ($p = 0.000$). Medicare was more common among hemiarthroplasty patients (92.4%) than total hip arthroplasty patients (88.5%, $p = 0.000$). In contrast, private insurance, including HMO, was higher for total hip arthroplasty patients (7.9% vs. 5.3%, $p = 0.000$). Medicaid and self-pay showed no significant differences between groups.

Table 2. Demographic differences in hemiarthroplasty vs. total hip arthroplasty patients (2016–2019).

	% Hemi (Yes)	% Total (Yes)	*p*-Value
Female	69.7	68.6	$p < 0.0001$
Medicare	92.4	88.5	$p < 0.0001$
Medicaid	0.822	0.813	$p = 0.54$
Private including HMO	5.3	7.9	$p < 0.0001$
Self-pay	0.4	0.4	$p = 1$

Based on the crosstabs provided (Table 3), the observed and expected numbers differ by racial category with respect to the surgical procedure chosen. For example, in the white cohort, 215,325 people chose hemiarthroplasty, whereas the expected number in a scenario with no effect of race on the type of surgery was 215,696.9. Looking more closely at the percentages, 88.5% of the white participants chose hemiarthroplasty, and 11.5% chose total hip arthroplasty. When these numbers are compared with other racial groups, subtle trends emerge. White patients were slightly more likely to undergo total hip arthroplasty than Black (9.6%), Hispanic (9.7%), and Asian or Pacific Islander (10.5%) patients. At the other end of the spectrum, Native American patients had a lower preference for her at 7.4%. Of note, those in the "other race" category were most likely to undergo total hip replacement, at 13.7%. Additionally, Pearson's chi-square test yielded a *p*-value of 0.000, highlighting the significance of the observed association.

Table 3. Crosstabulation of surgical procedure types by racial categories. Observed and expected counts with percentage distributions.

Race		Hemi	Total	
White	Count	215,325	27,975	243,300
	Expected Count	215,696.9	27,603.1	243,300.0
	%within Race	88.5%	11.5%	100.0%
Black	Count	10,225	1080	11,305
	Expected Count	10,022.4	1282.6	11,305.0
	%within Race	90.4%	9.6%	100.0%
Hispanic	Count	11,815	1270	13,085
	Expected Count	11,600.5	1484.5	13,085.0
	%within Race	90.3%	9.7%	100.0%
Asian or Pacific Islander	Count	4425	520	4945
	Expected Count	4384.0	561.0	4945.0
	%within Race	89.5%	10.5%	100.0%
Native American	Count	630	50	680
	Expected Count	602.9	77.1	680.0
	%within Race	92.6%	7.4%	100.0%
Other	Count	4080	650	4730
	Expected Count	4193.4	536.6	4730.0
	%within Race	86.3%	13.7%	100.0%
Total	Count	246,500	31,545	278,045
	Expected Count	246,500.0	31,545.0	278,045.0
	%within Race	88.7%	11.3%	100.0%
Pearson Chi-Square		*p*-value = 0.000		

An evaluation of surgical interventions for femoral neck fractures from 2016 to 2019 revealed gradual changes in the recommended surgical approach. Total hip arthroplasty (THA) adoption gradually increased over the four years, as shown in Figure 1.

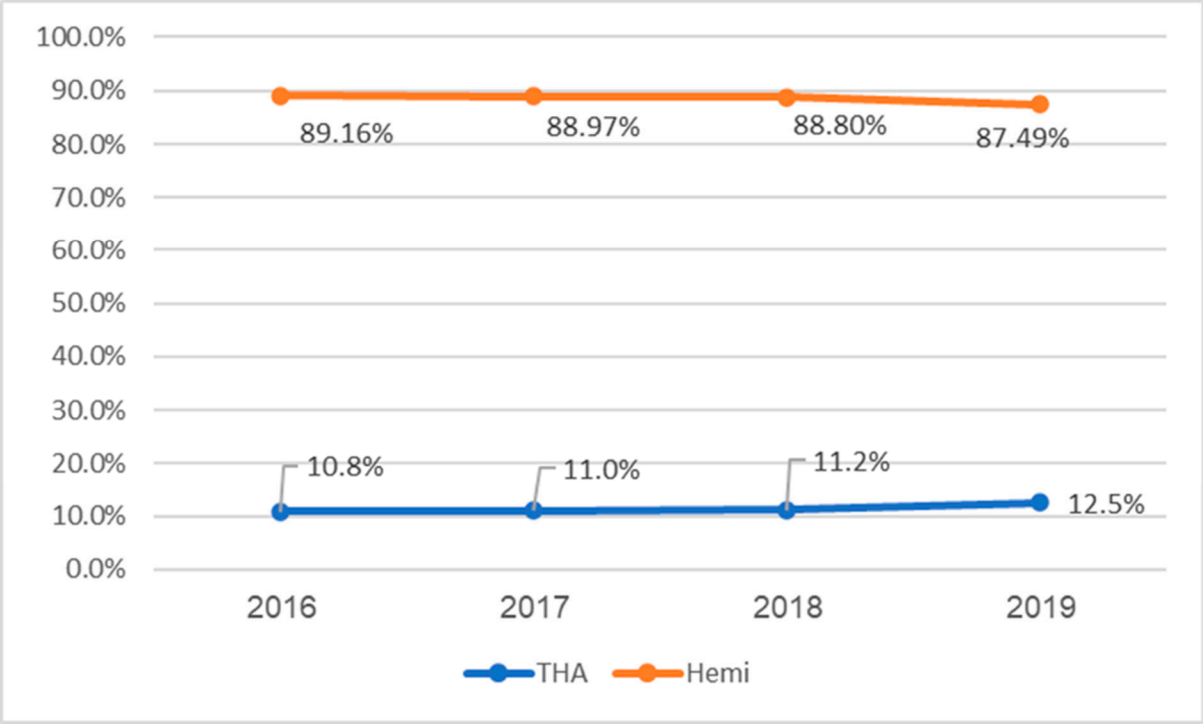

Figure 1. Percentage of hemiarthroplasty and total hip arthroplasty performed for femoral neck fractures between 2016 and 2019.

In 2016, 10.8% of surgeries were hip replacements; by 2019, this number increased to 12.5%. Conversely, the preference rate for hemiarthroplasty decreased from 89.16% in 2016 to 87.49% in 2019.

Statistical analysis confirmed that the yearly increasing trend in THA preference was statistically significant. These data suggested a paradigm shift in surgical priorities, with total hip arthroplasty gaining traction, albeit slowly, as the intervention of choice for femoral neck fractures over the observed period.

Figure 2 illustrates the mean age of patients undergoing these two surgical procedures over the specified years.

In 2016, the average age of patients who underwent total hip arthroplasty (THA) was 77.33 years, slightly rising to 77.4 years in 2017. A decrease was noted in 2018, with the mean age being 76.76 years, but the value marginally increased to 76.93 years in 2019. On the other hand, patients who underwent hemiarthroplasty had a consistently higher mean age compared with those who opted for THA. Their ages hovered around the early 82-year mark, starting with 82.39 years in 2016, slightly dropping to 82.28 years in 2017, and then stabilizing around 82.3 years in the subsequent years.

These data underscore an evident age disparity between the two patient groups, with hemiarthroplasty patients being consistently older on average compared with their THA counterparts over the observed period.

Figure 3 portrays the average hospital stay post-total hip arthroplasty (THA) or hemiarthroplasty from 2016 to 2019. THA patients' stays ranged from 5.07 days in 2016 to 4.95 days in 2019. In contrast, hemiarthroplasty patients began at 5.47 days in 2016 and decreased to 5.28 days by 2019. Hemiarthroplasty consistently resulted in more extended stays than THA throughout the study period. Additionally, both surgeries exhibited a statistically significant trend toward reduced hospitalization over time.

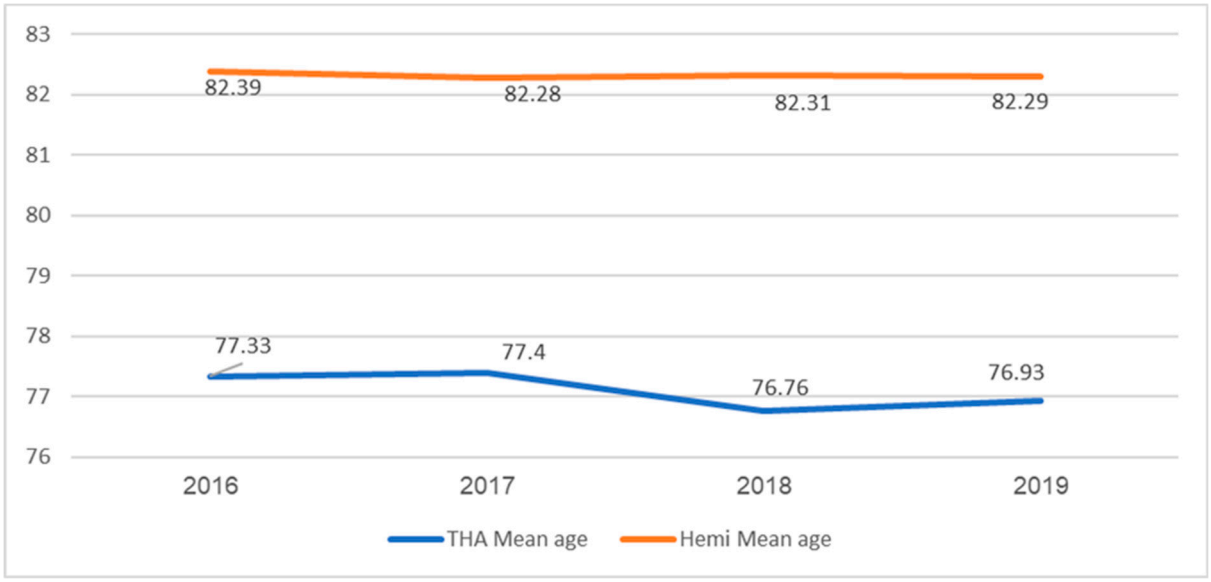

Figure 2. Age in years of hemiarthroplasty and total hip arthroplasty patients between 2016 and 2019.

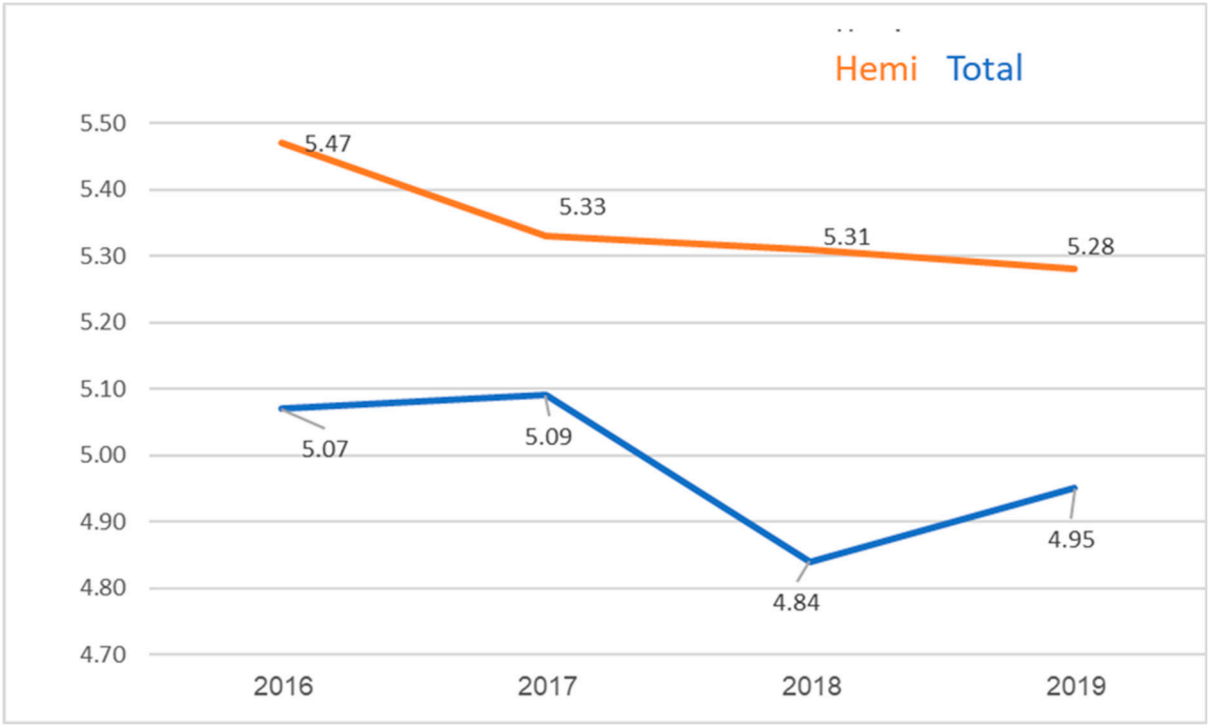

Figure 3. Length of stay in days of hemiarthroplasty and total hip arthroplasty patients between 2016 and 2019.

Figure 4 shows an apparent, statistically significant increase in treatment costs for both procedures over the period. Notably, total hip arthroplasty (THA) consistently presented higher charges than hemiarthroplasty, with the cost difference between the two also being statistically significant. By 2019, average charges for THA reached USD 91,365.65, while hemiarthroplasty amounted to USD 82,101.14.

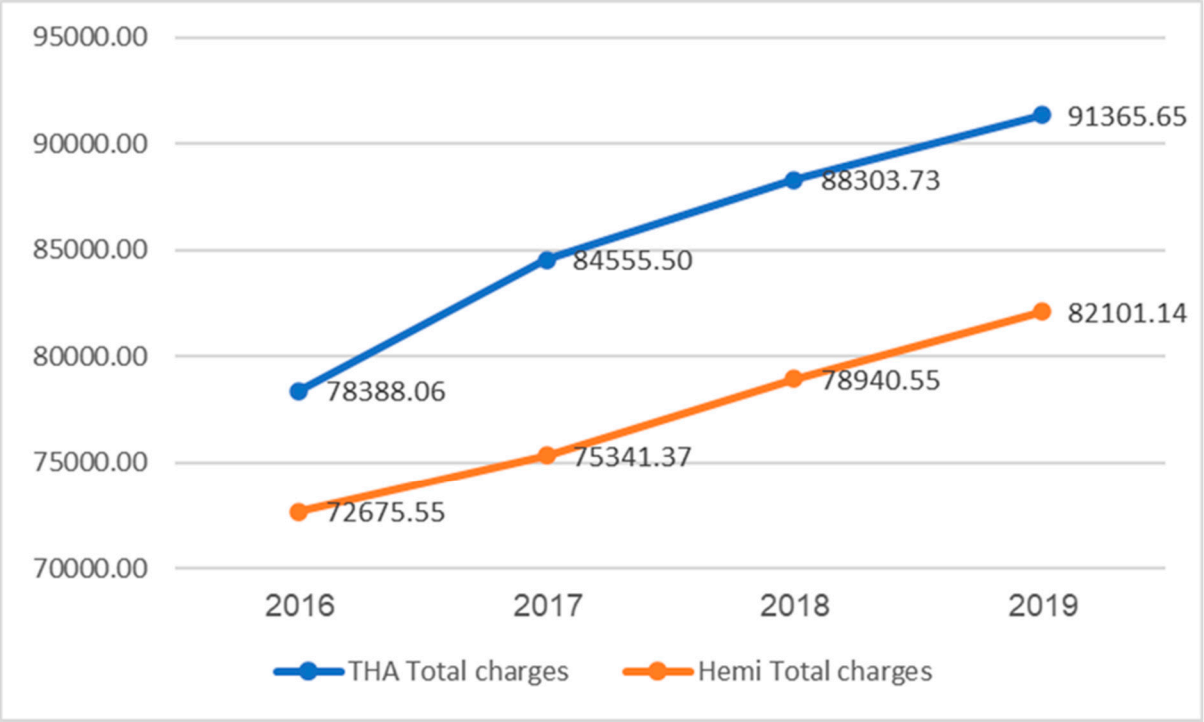

Figure 4. Mean charges for hemiarthroplasty and total hip arthroplasty patients in 2016 and 2019.

4. Discussion

Traumatic hip fractures, as well as other morbidities in the aging world, are becoming an integral part of health care for older people. Those injuries place a growing population at risk for death, health complications, and a deterioration in the quality of life [1,2], placing an enormous economic burden [11,12].

As surgery is the treatment of choice among those capable of surgery [3], the variety of surgical treatments and the variety of surgical and non-surgical considerations in choosing a surgical solution are challenging the healthcare society and make it difficult to establish clinical guidelines for choosing a surgical procedure for patients with femoral neck fractures [4,5].

THA and HA are popular treatments for individuals who suffer from a displaced femoral neck fracture, whose native hip joint cannot be preserved, or those who will benefit from arthroplasty because of pre-existing hip conditions. Moreover, other factors such as general patient health, age, activity level, anatomical fracture characteristics, and surgeon preference play a role in choosing treatment [4,5].

Our study shows that while comorbidities influence the choice between THA and HA, the overall patient condition, not just the presence of a disease, is crucial in surgical decision-making. For example, patients with well-controlled conditions may be better suited for THA, whereas those with poor health may require HA. This is a limitation of our study, as the NIS database does not fully capture the complexity of patient health. We have noted this limitation in the relevant section to ensure our findings are interpreted with this in mind.

While some recent studies demonstrated that THA may have superior post-operative function, pain relief, and lower re-operation rates when compared with HA in the setting of displaced femoral neck fractures [13,14], concerns for THA include longer operative time, increased surgical complexity, risk of postoperative dislocation, and higher initial cost [15].

A recent study based on the NIS database also found a statistically significant increase in the percentage of femoral neck fractures treated with THA in the United States between 2005 and 2014, with a constant inclination with the THA percentage from 8.3% in 2005 rising to 13.7% in 2014 [10]. Our study showed a similar trend, with a constant inclination

in the THA percentage from 10.8% in 2016 to 12.5% in 2019. The lower trend in the latest study could arise from the difference in the coding system, changing from ICD 9 in the recent research to ICD 10 in our study.

The same study found that patients treated with HA had more comorbidities and were, on average, older than patients who underwent THA, a conclusion that correlates with our results as well with most comorbidities examined in our study led to a significant correlation with HA. Mental state comorbidities such as Alzheimer's, Parkinson's, and Psychosis, as well as chronic systemic diseases such as CHF, CKD, or Chronic Lung disease, led to an even stronger correlation. Accumulated evidence suggests HA has a reduced dislocation rate, less complex surgery, shorter operation time, and less blood loss compared with THA [16], which can explain the tendency of surgeons to offer more straightforward procedures to those who suffer from severe comorbidities. In addition, some comorbidities tend to exist simultaneously, which makes these patients even more fragile and, as a result, candidates for the more straightforward procedure.

Examining gender trends reveals that women tend to undergo HA more than THA. The complexity of hip fracture from a gendered perspective is diverse and composed of the gendered nature of lifestyle, which affects where they fell, the sorts of help required when planning recovery and discharge from the hospital, the family situation, as older women often live alone and are older than men when they fracture their hips, and the tendency to other comorbidities such as osteoarthritis, which women suffer more than men. Those factors probably affect the decision to make arthroplasty over fixation, making it even harder to predict [17,18].

By analyzing surgery treatment by insurance type, our study, consistent with other studies, finds that privately insured patients tend to be treated by THA significantly more than HA [10,19]. Analyzing observed and expected surgical procedure numbers differ by racial category reveals significant variation in the amount of THA and HA between racial groups. While white patients are divided between THA and HA relatively as their portion from the total cohort, Blacks, Hispanics, and Asians tend to be treated with HA.

For example, in the white cohort, 11.5% chose total hip arthroplasty. When these numbers were compared with other racial groups, subtle trends emerged. White patients were slightly more likely to undergo total hip arthroplasty than Black (9.6%), Hispanic (9.7%), and Asian or Pacific Islander (10.5%) patients. In contrast, Native American patients had a lower preference for THA at 7.4%. Of note, those in the "other race" category were most likely to undergo total hip replacement, at 13.7%. Additionally, Pearson's chi-square test yielded a p-value of 0.000, highlighting the significance of the observed association.

While some studies did not find a racial effect on treatment type on femoral fractures [20], others were consistent with our research and found that racial bias significantly affects the treatment chosen for hip fracture [10,21]. Multiple studies examined bias in clinical practice, in particular about race and gender, and found it a persistent cause of healthcare disparities [22–24] and even suggested that healthcare providers appear to have an implicit bias in terms of positive attitudes toward whites and negative attitudes toward people of color [25]. As well as gender bias, racial medical treatment bias is hard to examine, and they affect each other, such as socioeconomic status, insurance type, living area, comorbidities among some ethnic groups, etc. Still, further research is warranted to elucidate the true causes of these observed disparities.

From 2016 to 2019, it seems that the recommended surgical approach changed. THA for femoral neck fractures was gradually preferred over HA, although HA was still much more popular. Although the mean LOS among HA patients was slightly higher than THA, the mean charges for HA were much lower than THA, and while both treatments became more expensive, THA became more expensive. For example, the HA price rose in 3 years from USD 72,675 to USD 82,101, representing an elevation of 12.9%, and the THA price rose from USD 78,388 to USD 91,365, representing a rise of 16.5%.

There were limitations to our study that were associated with NIS database studies [26–28]. The NIS database relies on codes intended for billing; therefore, we could not obtain data

on the severity of comorbidities, prior functional status, or extent of fracture displacement. These data, as these factors, likely play a significant role in a surgeon's surgical preference independent of age or sex, so the findings of our study should be interpreted with caution.

Despite these limitations, this article provides a glance at trends in hip fracture treatments, their diversity among genders and races, and their costs. Our study indicated that THA is increasingly performed as the treatment of choice in traumatic hip fracture, is increasing in charges relatively more than HA, and is associated with a shorter LOS.

5. Conclusions

This study highlights evolving trends in surgical management for femoral neck fractures and identifies factors influencing treatment decisions. Understanding these trends and disparities is crucial for optimizing patient care and informing future clinical guidelines. Further research should focus on assessing different surgical approaches' long-term outcomes and cost-effectiveness.

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Informed Consent Statement: Informed consent for participation is not required because of the de-identified nature of the NIS dataset.

Data Availability Statement: Data available in a publicly accessible repository. The data presented in this study are openly available in HCUP by NIS. [HCUP] [https://hcup-us.ahrq.gov/tech_assist/centdist.jsp] (accessed on 1 December 2023).

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

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