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Bipolar hemiarthroplasty in late-geriatric femoral neck fracture: Impact on survival and quality of life

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Abstract: Femoral neck fractures in late geriatric patients pose significant challenges. This study aims to evaluate the effects of bipolar hemiarthroplasty on the 5-year survival rates and quality of life of late geriatric patients with femoral neck fractures. This longitudinal study involved patients over 75 years old who underwent bipolar hemiarthroplasty for femoral neck fractures. The Harris Hip Score (HHS) and the SF-12 were used to assess postoperative hip function and overall quality of life. The Charlson Comorbidity Index (CCI) was employed to evaluate comorbid conditions. Pearson or Spearman tests were used to measure the correlation between HHS, SF-12, and CCI. Kaplan-Meier survival curves were used to visualize survival trends. A total of 150 patients were included. The results of CCI and survival rate are CCI of 3 (mean 4.15 years); CCI of 4 (mean 4.10 years); CCI of 5 (mean 3.5 years); and CCI of 6 (mean 2.9 years). The most common preoperative condition among patients was Garden type III femoral neck fractures (56%). The hazard ratio increased by 1.398 ($p = 0.005$) as the CCI value increased. The survival rate for most patients in this study was over three years (52.6%). The average quality of life score for patients (Short Form-12) was 37.65 for physical components and 46.58 for mental components. Quality of life and hip function in late geriatric patients after bipolar hemiarthroplasty are low, with CCI linked to survival. This highlights the need for thorough preoperative evaluation and targeted rehabilitation.

Keywords: *Late-geriatric, Bipolar hemiarthroplasty, Femoral neck fracture, Quality of life, Survival rate.*

1. Introduction

Trauma is increasingly common in geriatric patients, with fractures being a frequent injury among this demographic. With rising life expectancy and advancements in medical care, individuals are living longer and better lives [1]. According to a study by Fischer et al., over three-quarters of proximal femoral fractures (PFF) occur in patients over 75 years old in Germany [2]. Globally, the number of hip fractures is expected to rise to between 7.3 and 21.3 million by 2050 due to demographic shifts and an increasing proportion of older adult people in the population [2, 3]. For older adults, PFF is often a life-changing event, significantly impairing their already compromised independence. High comorbidity rates are also prevalent, with 50% of PFFs occurring in individuals who already require nursing care [2]. The geriatric population is further divided into early geriatrics (ages 65-74) and late geriatrics or older adults (ages 75 and above) [4]. Older adult patients often have multiple comorbidities, making them more susceptible to postoperative complications following fractures [5]. The increased risk of mortality after femoral neck fractures is well-documented, with one-year mortality rates ranging from 12-33%. These patients often fail to regain their pre-fracture functional levels [6]. There are significant

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differences between early geriatric and older adult patients. The physical activity of healthy early geriatric individuals is comparable to that of individuals approximately 7.5 years younger in men and 10 years younger in women. The functional independence in older adult patients with diabetes mellitus (over 65 years) is comparable to that of individuals approximately 15 years younger [7]. Overall, fractures in geriatric patients present numerous challenges. Age-related factors such as comorbidities and polypharmacy complicate care, increasing the risk of serious complications and loss of functional ability [8]. Factors contributing to trauma in geriatric patients include fall risks, with even low-energy injuries potentially causing significant damage [6]. Comprehensive management, including preoperative assessment, fall risk evaluation, and preventive measures, is crucial. These factors should be integrated into the history and physical examination of all geriatric patients [9]. With the increasing life expectancy in Indonesia and the high incidence of femoral neck fractures among the older adults, healthcare facilities will encounter more geriatric patients, particularly those aged around 75 (late geriatrics), requiring surgical intervention [9]. This study aims to evaluate preoperative status, survival rates, and quality of life outcomes for these patients. By identifying factors influencing these outcomes, the study seeks to contribute to better management strategies and clinical practices, ultimately enhancing the care and health outcomes for geriatric patients with these conditions.

2. Materials and Methods

2.1. Study Design

This study employed a longitudinal study design with an analytical observational approach. Specifically, the study focused on analyzing the correlation between preoperative, operative, and postoperative factors with survival rates and quality of life in older adult patients who have undergone surgery for femoral neck fractures.

3. Subjects

The sampling procedure was total sampling. The sample consisted of older adult patients (aged 75 and older) with femoral neck fractures who underwent surgical treatment from January 2017 to April 2019 at Dr. Soetomo General Academic Hospital and Orthopaedic Hospital Surabaya. The inclusion criteria were: 1) Late-geriatric patients, defined as individuals aged 75 years and older; 2) Patients with femoral neck fractures who received bipolar hemiarthroplasty at the specified hospitals within the study period; 3) Patients who consented to participate in the study, evidenced by signing an informed consent form. Exclusion criteria included: 1) Patients with femoral neck fractures treated non-operatively; 2) Patients with neurological deficits caused by central nervous system injuries; 3) Patients who have undergone lower extremity amputation; 4) Patients with periprosthetic fracture; 5) Incomplete patient data. Using total sampling and considering inclusion and exclusion factors, we collected data from 150 patients.

4. Variables

Comorbidities refer to existing health conditions or burdens that impact an individual's physiology, defined as any physiological dysfunctions or chronic health issues, and this study describes patient comorbidities using the Charlson Comorbidity Index.10 Femoral Neck Fracture Severity (Garden Classification) is a system that evaluates factors such as fracture displacement, complexity, and the arrangement of trabecular bone in the femoral head and neck using AP pelvic radiography; the four types are incomplete and valgus impacted (Type I), complete and non-displaced (Type II), complete and partially displaced (Type III), and complete and fully displaced (Type IV) [10]. Survival Rate represents the percentage of individuals still alive after a specific period following diagnosis or treatment, and it may be reported as a general percentage or over a specified timeframe; this study uses a five-year survival rate, considering that lower extremity recovery usually requires about one year, followed by assessment of survival over the next year post-surgery. The Harris Hip Score (HHS)

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evaluates post-operative outcomes for pelvic fractures and is highly valid and reliable in assessing femoral neck fracture outcomes; HHS outcomes are rated as follows: 90–100 (excellent), 80–89 (good), 70–79 (fair), 60–69 (poor), and below 60 (failure) [11]. Adapted from SF-36, the Short Form-12 (SF-12) uses select questions from its eight dimensions to provide a shorter assessment with similar effectiveness, yielding two scores: the Mental Component Score (MCS-12) and Physical Component Score (PCS-12), each ranging from 0 to 100; higher scores indicate better function, assessing quality of life one-year post-surgery [12]. All patients have undergone surgery at least within the past 5 years.

5. Data Collection

Data collection involved reviewing medical records and administering questionnaires. Medical records were used to assess the Charlson Comorbidity Index. Patients or their family members, with the patient's knowledge and consent, completed the questionnaires. The Harris Hip Score (HHS) and SF-12 were used for assessing quality of life. The data on the Mechanism of Injury (MOI) were also collected. For patients missing specific quality of life assessments (e.g., lost to follow-up), we applied censoring at the time of their last valid assessment to avoid skewing results.

6. Statistical Analysis

The collected data were statistically analyzed using the Kolmogorov-Smirnov test for normality, followed by Pearson or Spearman tests for correlation, and Kaplan-Meier survival curves to visualize survival trends. We also applied Cox proportional hazards models to estimate the hazard ratio of death. All statistical analyses were performed using SPSS 27.0.0 for Windows (SPSS Inc. Chicago, IL, USA). This study has been ethically approved by the research ethics committee of our institution (Ethical Clearance No. 1268/LOE/301.4/III/2023).

7. Results

The study examined a group of older adult patients, specifically those in the late-geriatric category (over 75 years). From January 2017 to April 2019, a total of 150 patients were included in the study. The HHS and SF-12 scores indicated low scores in hip function (mean = 67.25) and quality of life (mean PCS 37.65 ±2.596; mean MCS 46.58 ± 6.720) post-bipolar hemiarthroplasty (Table 1). Moreover, the CCI revealed a significant presence of comorbid conditions among the patients (Table 2), which were found to have a marked impact on survival rates. The most frequent comorbidity was hypertension (33.3%), and the least frequent was gastritis (3.3%) (Table 2). The most common preoperative condition among patients was Garden type III femoral neck fractures (56%), with the highest Charlson Comorbidity Index (CCI) score being 5 (51.3%). In our research, we did not find any CCI scores below 3 (Table 1). Patients with a CCI of 3 exhibited a mean survival rate of 4.15 years (range 3.9–4.3); patients with a CCI of 4 had a mean survival rate of 4.10 years (range 3.8–4.4); those with a CCI of 5 had a mean survival rate of 3.5 years (range 3.3–3.7); and those with a CCI of 6 had a mean survival rate of 2.9 years (range 2.5–3.3) ($p = 0.010$) (Table 3). The highest survival rate (72%) was observed in the first year after surgery (Figure 1). Additionally, the hazard ratio rose by 1.398 ($p = 0.005$) with each increment in the CCI score, highlighting the fact that certain comorbidities considerably elevated the mortality risk.

8. Discussion

Femoral neck fracture is a common injury in older adult patients [1]. According to a study in the European Journal of Medical Research, more than three-quarters of proximal femur fractures (PFF) occur in patients over 75 years of age [2]. Research conducted by Tinubu et al. indicates that the risk of femoral neck fractures is quite high, ranging from 40% to 50% in older adult women and 13% to 22% in older adult men [1]. According to Orimo et al., the definition of geriatric age groups is as follows: ages 65-74 are considered early geriatric, and ages over 75 are considered late geriatric Orimo, et al. [4]. Fischer, et al. [2] provide insights into the care of late-geriatric patients, stating that medical care for

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older adult patients with femoral neck fractures is highly challenging. Interdisciplinary orthogeriatric management can reduce hospital stay duration, complications, and mortality [2]. Key aspects include pain management, early mobilization, fluid management, delirium prevention, and surgical care options based on comorbidities and biological age [2]. Our study generally aligns with previous research, with 62% of our sample being female and the average age of the sample being 79.68 years. Gender is a widely studied factor in patients with femoral neck fractures, particularly concerning its impact on survival probability and mortality. In late-geriatric patients, women physiologically experience osteoporosis more rapidly, potentially worsening their prognosis post-fracture. In contrast, late-geriatric men more frequently suffer from dementia, which can also affect survival probability [13]. A long-term study by Tiihonen, et al. [14] over 14 years found that women are three times more likely to sustain femoral neck fractures compared to men, with a significant difference between the genders [14]. However, Jordaan, et al. [15] said that there was no significant difference in survival rates between the genders [15]. Our research aligns with these findings, showing that the survival rate for women is 2.9 years, while for men, it is 2.8 years. Based on the mechanism of injury (MOI), fractures are divided into two categories: low-energy (trivial) injury and high-energy (non-trivial) injury. In older adult patients, low-energy fractures are the most common MOI and are often associated with osteoporosis, which increases the risk of future fractures [10]. Previous studies have indicated that the predominant MOI in patients undergoing arthroplasty for femoral neck fractures is trivial injury Li, et al. [13] and Jordaan, et al. [15]. Jordaan, et al. [15] reported that 91.7% of patients sustained their injuries through trivial injuries [15]. Additionally, Zhang, et al. [16] found that 97.58% of cases were due to falls rather than accidents [16]. This is consistent with our findings, which show that 87.3% of the sample experienced trivial injuries. However, this result did not have a significant impact on the survival rate ($p = 0.194$). The mechanism of injury, primarily trivial in nature, underscores the fragility of this age group. The majority of fractures were classified as Garden type III, suggesting a significant displacement that often necessitates surgical intervention like bipolar hemiarthroplasty to restore function and mobility [17].

Comorbidities significantly affect the quality of life and mortality in late-geriatric patients [5]. The Charlson Comorbidity Index (CCI) is a system used to assess the probability of life expectancy based on the number and severity of comorbidities. This consistency across different studies reinforces the importance of considering comorbidities in the management and prognostication of older adult patients undergoing bipolar hemiarthroplasty [17, 18]. According to research by Jiang, et al. [19] the mortality rate in patients with hip fractures increases proportionally with a higher Charlson Comorbidity Index (CCI) [19]. Additionally, a study by Zhang, et al. [16] noted that the survival probability for hip fracture patients decreases by 31% with each unit increase in CCI [16]. Our research similarly found that the average survival rate decreases significantly with increasing CCI values. Specifically, the survival rate declines by 5.8% with each unit increase in CCI ($p = 0.010$; hazard ratio 1.398). The most common comorbidities in our sample were hypertension (33.3%), diabetes mellitus (20%), and cerebrovascular accident (13.3%). This contrasts with other studies, which often identify congestive heart disease as the most prevalent comorbidity, typically accompanied by hypertension Li, et al. [13]. Irianto et al. also mentioned in their study that diabetes mellitus and hypertension were significant contributors to vertebral and hip fractures, which are categorized as osteoporotic fractures. According to a recent meta-analysis, diabetes mellitus increases the risk of fractures of any kind [6]. Hypertension also contributes to the reduction of bone mineral density (BMD), either by reducing the local blood supply to the bone or due to the effects of antihypertensive medications taken by patients. These factors might explain why these comorbidities are significant for osteoporotic fractures [6]. These differences may be attributed to variations in lifestyle, culture, traditions, and race, which influence the prevalence of comorbidities [6]. Femoral neck fractures are divided into four groups according to the Garden Classification. This study only found grade III and IV fractures, with grade III being the most common (56%). The Garden classification is used to determine the severity of femoral neck fractures [20]. Garden types I and II are stable and can be treated with internal fixation, while types III and IV are unstable and require arthroplasty [10]. Our study shows that the severity level according to the

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Garden classification does not significantly influence the patient survival rate. Prolonged LOS after arthroplasty for geriatric femoral neck fractures is associated with an increased risk of 30-day mortality [6, 18]. Addressing and mitigating modifiable risk factors that delay discharge may enhance early outcomes in this patient population. A study by Schneider, et al. [21] reported that geriatric patients with a post-surgical LOS of 8-14 days had higher odds of mortality (OR = 2.453) compared to those with an LOS of 4-7 days (OR = 1.759), indicating that longer post-surgical stays increase the risk of mortality after discharge ($p < 0.001$) [21]. Our study found that the average survival rate for patients with an LOS of 4-7 days was 3.8 years, while for those with an LOS of 8-14 days, it was 3.6 years ($p = 0.405$). Although this difference is not statistically significant, it suggests that longer hospital stays may be associated with lower survival rates. This implies that the quality and intensity of postoperative care received during hospitalization may be more influential than the duration of the stay itself. Furthermore, comorbidities appear to have a greater impact on survival rates than the length of postoperative care [15, 21]. Early surgery is associated with improved mean survival time and a significant reduction in one-year mortality in older adult patients with femoral neck fractures. However, the demand for urgent surgery often exceeds available resources in many healthcare systems [22, 23]. A study by Poh and Lingaraj [22] found that patients undergoing surgery more than 48 hours post-injury had an odds ratio of 1.766 compared to those operated on within 48 hours ($p = 0.045$) [22]. Additionally, research by Suttaphakti, et al. [23] indicated that the early surgery group had a lower one-year mortality rate than the delayed surgery group without preoperative medical conditions ($p = 0.011$, hazard ratio = 8.08) [23]. Our findings align with these studies, showing that patients who had surgery within 48 hours had a higher mean survival rate (3.8 years) compared to those who had surgery after 48 hours (3.6 years), although the difference was not statistically significant ($p = 0.903$). This suggests that the quality of care provided is nearly equivalent for both early and delayed surgery patients, though earlier intervention is preferable. The quality of life in late geriatric patients is crucial, as it can significantly impact the national healthcare burden for their treatment and maintenance. Zhao et al. reported that hemiarthroplasty often leads to acetabular erosion and protrusion, particularly in patients over 60 years old [24]. Erosion accounted for 78.1% of revision surgeries in the hemiarthroplasty group, and it is associated with pelvic pain and poor function, becoming more pronounced with longer follow-up periods [24]. Additionally, regarding comorbidities, Gatot, et al. [25] stated that a CCI score ≥6 predicts higher 90-day readmission rates, poorer HHS, and lower potential for functional recovery one-year post-surgery in hip fracture patients [25]. According to SF-12 scores, Orive, et al. [12] found that physical quality of life is low, although mental quality of life remains good six months post-surgery [12]. Our study found that quality of life based on the HHS is generally low, although 13.3% of patients achieved good scores. Both HHS and SF-12 scores indicated low values, with no significant differences observed (p-values based on Garden type: HHS = 0.139, PCS-12 = 0.823, MCS-12 = 0.714; based on CCI: HHS = 0.383, PCS-12 = 0.758, MCS-12 = 0.577). This could be due to older adult patients experiencing difficulties in rehabilitation and mobility post-surgery, lower bone quality (osteoporosis), and reduced muscle strength. These mobility limitations can negatively impact their HHS due to decreased physical activity and fitness.

Although not all of our research findings align with other studies, there is one consistent and important data point: the most influential factor on the survival rate of late-geriatric patients undergoing bipolar hemiarthroplasty after a femoral neck fracture is comorbidity [6]. Our research indicates that higher CCI values are associated with lower survival rates. Additionally, a higher CCI is linked to an increased hazard ratio, indicating a higher risk of mortality. Our study found a significant decrease in the survival rate during the first year across all variables examined. Researchers suggest that this may be due to the advanced geriatric stage and the predominance of comorbid conditions. Therefore, even though many patients died within the first year after bipolar hemiarthroplasty, their survival was still better than the general life expectancy average.

In our findings, the highest mortality rates were observed in the first year. Therefore, it is advisable to consider enhancing postoperative rehabilitation programs for late geriatric patients undergoing hip

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arthroplasty. Our study's emphasis on the CCI's role in influencing survival highlights the necessity for thorough preoperative assessment and optimization of comorbid conditions. It suggests that while BHA can substantially improve functional outcomes, the underlying health status of patients profoundly impacts long-term survival. Therefore, a multidisciplinary approach involving geriatricians, cardiologists, and other specialists is crucial in the perioperative management of these patients to mitigate risks and enhance outcomes.

Variability in care, such as non-operative management and rehabilitation protocols, can affect outcomes and limit the study's generalizability. Future research with multicenter studies and longer follow-up will help provide a clearer understanding of bipolar hemiarthroplasty's impact on older adult patients' survival and quality of life. The study could explore multiple variables and scoring systems for assessment. Additionally, it could further explore the preoperative functional status of patients.

This study has several limitations. First, this study was conducted at two hospitals in Surabaya, which limits the generalizability of the findings to other regions or healthcare settings. Multicenter studies could provide a more diverse patient population and more representative outcomes. Second, the use of medical records to assess comorbidities presents a limitation, as not all comorbid conditions may have been documented or thoroughly examined at the time of treatment. Some relevant health issues might not have been identified or accurately recorded, potentially underestimating the full impact of comorbidities on survival and quality of life outcomes.

9. Conclusion

The one-year survival rate for older adult patients with femoral neck fractures after bipolar hemiarthroplasty is 72%. Quality of life, measured by HHS and SF-12, is generally low. Survival rates are significantly influenced by comorbidities (CCI, p=0.010), with a notable decline in the first year. These findings emphasize the need for thorough preoperative evaluation and targeted postoperative care to optimize outcomes.

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Ethical Clearance:

This study has been ethically approved by the research ethics committee of our institution (Ethical Clearance No. 1268/LOE/301.4/III/2023).

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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