ORIGINAL ARTICLE

# Incidence and Mortality of Bone Cement Implantation Syndrome after Hemi Arthroplasty: A Retrospective Analysis in a Single Institute of Karachi

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**ABSTRACT**

**Objective:** To investigate the incidence and mortality associated with Bone Cement Implantation Syndrome following cemented hemiarthroplasty for femoral neck fractures.

**Study Design:** Retrospective cohort study.

**Place and Duration of Study:** The study was conducted at the Department of Orthopedics, Dr. Ziauddin Hospital, Karachi, Pakistan from 1st January 2022 to 31st December 2022.

**Methods:** Patients who underwent cemented hemiarthroplasty at the Department of Orthopedics, Dr. Ziauddin Hospital, Karachi, Pakistan. The study included patients with complete medical records documenting cemented hemiarthroplasty as the primary treatment for femoral neck fractures. The incidence and severity of Bone Cement Implantation Syndrome were identified and categorized using established criteria. The association between 30-day mortality and Bone Cement Implantation Syndrome grade was analyzed using a two-tailed Fisher's exact test.

**Results:** Out of 58 patients initially reviewed, 56 were included in the final analysis, with an observed incidence of Bone Cement Implantation Syndrome of 35.7% (20 patients). Among these, 5 patients exhibited severe Bone Cement Implantation Syndrome (grades 2 and 3). The analysis revealed no statistically significant association between the severity of Bone Cement Implantation Syndrome and 30-day mortality ($P$ = 0.122). Demographically, 80.36% of the patients were male, with a median age of 76.5 years. Comorbidities included hypertension (64.29%) and diabetes (30.36%).

**Conclusion:** Our study found a notable incidence of Bone Cement Implantation Syndrome remains a critical consideration in cemented hemiarthroplasty, its management does not significantly impact short-term mortality. Our findings underscore the importance of vigilant perioperative care and the potential benefits of larger Bone Cement Implantation Syndrome registries for improving patient outcomes.

**Keywords:** *Arthroplasty, Bone Cements, Femoral Neck Fractures, Hemiarthroplasty, Mortality.*

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## Introduction

Hip fractures represent a significant global health challenge, disproportionately affecting the aging population due to increased bone fragility and higher fall risks. The prevalence of such injuries is not merely a medical concern but also a substantial socioeconomic burden, with an estimated 6% of men and 18% of women worldwide experiencing hip fractures at some point in their lives. The incidence escalates alarmingly among individuals over 65, marking hip fractures as a critical issue in geriatric health care.[1,2] Beyond the immediate health consequences, hip fractures are associated with substantial costs and a high mortality rate, reaching

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up to 30% within the first year.[1] Furthermore, it is predicted that there will be 6 million hip fractures by 2050, and half of them will be from Asian countries.[3,4] Hemiarthroplasties and total hip replacements are therefore growing in popularity, particularly among elderly patients with significant comorbidities.[5] The trend towards cemented implants is particularly noteworthy. While the choice between cemented and cementless implants remains surgeon-dependent. Cemented implants, in particular, offer distinct advantages for patients with osteoporotic bone, enabling faster mobilization and reducing the risk of periprosthetic fractures.[6,7] These benefits translate to a lower risk of periprosthetic fractures, both during and after surgery.[5,8]

Despite the advantages of cemented implants, a well-known and potentially life-threatening complication exists: Bone cement implantation syndrome (BCIS).[3,9,10] Clinically characterized by hypotension, hypoxemia, and altered mental status, BCIS typically occurs during femoral or acetabular prosthesis cementation and is likely caused by embolic fat particles or polymethylmethacrylate (PMMA) fragments.[1,8] Although BCIS can occur during other surgical stages, its association with cemented procedures is well established.[3] A few studies demonstrate that its incidence varies from 27.8% to 38%, and the intraoperative mortality rate fluctuates between 0.06% and 0.12%.[11,12] Hence, this retrospective analysis aims to address these knowledge gaps by examining the incidence and mortality associated with BCIS in patients undergoing hemiarthroplasty with cemented implants presenting at a tertiary care hospital, Karachi, Pakistan. By analyzing a specific patient population, this study seeks to contribute valuable insights into the management and potential mitigation strategies for this complex complication.

## Methods

The study was conducted at the Department of Orthopedics, Dr. Ziauddin Hospital Karachi, Pakistan from 1st January, 2022 to 31st December 2022. Patients who underwent cemented hemiarthroplasty as the primary treatment for femur neck fractures during the study period were included. Complete medical records documenting the procedure were mandatory for inclusion. Conversely, patients who underwent non-acute procedures, those with fractures caused by malignancy, periprosthetic fractures, or revision arthroplasty, and those with incomplete medical records were excluded.

After obtaining ethical approval from the Ethical Review Board of the hospital vide letter no: ERC#27-12/21 held on dated: 22th December 2021. Researchers conducted a three-step data collection process; first, an electronic medical record (EMR) review identified all patients who underwent hip hemiarthroplasty during the specified timeframe. Second, individual operating notes were examined to confirm the use of cemented implants. Finally, for each eligible patient, demographic information and co-morbidities were extracted. Demographic data included age at surgery, sex, and comorbidities, which were hypertension and diabetes. The primary outcome variable was the incidence of BCIS following cemented hemiarthroplasty. Secondary outcomes included investigating 30-day mortality stratified by BCIS grade. BCIS cases were identified and categorized based on their severity using established criteria. Grade 1 included a decrease in systolic blood pressure (SBP) of 20-40% or oxygen saturation (SaO2) below 94%. Grade 2 encompassed a more significant SBP decrease exceeding 40% or unexplained loss of consciousness: the most severe grade, BCIS grade 3, involved cardiovascular collapse requiring CPR intervention. Researchers identified and graded BCIS cases through a manual review of surgical and anesthesia records.

Statistical analysis was performed using SPSS version 23. Mean and standard deviation (SD), median, and interquartile range (IQR) were reported for numeric data. Frequency and percentage were reported for categorical data. A two-tailed Fisher's exact test was employed to evaluate the association between 30-day mortality and BCIS grade. A *P*-value of less than 0.05 is considered statistically significant.

## Results

A total of 58 patients were included in the final analysis. Surgery performed for purposes other than primary fracture repair led to the exclusion of 02 cases. With a median age of 76.5 years (IQR=8.5), 19.64% of the patients were female and 80.36% were male. Of 56 patients, 64.29% had hypertension

**Table-1: Baseline characteristics of included patients (n=56)**

| Characteristic | Median (IQR) or n (%) |
|---|---|
| Age (years) | 76.5 (8.5) |
| Gender | |
| Male | 45 (80.36%) |
| Female | 11 (19.64%) |
| BCIS status | |
| No | 36 (64.29%) |
| Non-Severe (Grade 1) | 15 (26.79%) |
| Severe (Grade 2 to 3) | 5 (8.93%) |
| Hypertension | |
| Yes | 36 (64.29%) |
| No | 20 (35.71%) |
| Diabetes | |
| Yes | 17 (30.36%) |
| No | 39 (69.64%) |

**Table-2: Comparison between Bone Cement Implantation Syndrome (BCIS) grade and 30-day mortality (n=56)**

| BCIS Grade | Died | Survived | *Fischer exact test* value | *P*-value |
|---|---|---|---|---|
| No | 0 | 36 (64.3%) | | |
| Non-Severe (Grade 1) | 3 (5.4%) | 12 (21.4%) | 8.043 | 0.122 |
| Severe (Grade 2 to 3) | 1 (1.8%) | 4 (7.1%) | | |

and 30.36% had diabetes. The BCIS was observed in 20 patients, among them 5 had severe BCIS (grades 2 and 3). (Table-1).

In non-severe BCIS, three patients died within 30 days, whereas in severe BCIS, one patient died. There is a statistically insignificant association between the grade of BCIS and 30-day mortality, with *P*=0.122. (Table-2).

## Discussion

The global rise in the incidence of hip fractures, especially within the elderly population, highlights an urgent call for optimized surgical interventions that not only address the immediate concerns of fracture repair but also mitigate the risks of complications such as BCIS.[13] BCIS is a significant factor in intraoperative mortality and morbidity after cemented hip arthroplasty, and may result in hypoxia, hypotension, and loss of consciousness occurring around the time of bone cementation.[14,15] The pathophysiology of BCIS is not fully understood. Still, it is believed to involve embolization of marrow contents and vasoactive substances into the bloodstream during cementation, leading to cardiovascular and pulmonary complications.[16]

In our retrospective analysis at Dr. Ziauddin Hospital, Karachi, we observed a 35.7% incidence of BCIS among patients undergoing cemented hemiarthroplasty for femoral neck fractures. Notably, there was no statistically significant association between BCIS severity and 30-day mortality. These findings suggest that while BCIS is relatively common, its severity may not directly correlate with short-term mortality in our patient cohort. This finding aligns with European registry studies reporting similar BCIS incidences in hip fracture surgeries without independent associations with mortality.[5,8] Another study reported a 28% incidence of BCIS in patients undergoing cemented hemiarthroplasty for femoral neck fractures.[17] Additionally, a study from the United States reported a BCIS incidence of 35% in cemented hemiarthroplasty cases.[18] However, in another study,

BCIS occurs in arthroplasty procedures and is associated with an increased risk of death within 30 days, with factors such as obesity, smoking, and diabetes increasing the risk of severe BCIS.[19] Our findings are consistent with those reported by Ekman et al., indicating no significant increase in immediate postoperative mortality risk after total hip arthroplasty or hemiarthroplasty due to cementing.[20] This supports the hypothesis that cemented arthroplasty, despite concerns regarding BCIS, does not inherently elevate perioperative or postoperative mortality risks. Similarly, Yang. et al., noted the incidence and risk factors of BCIS in bone tumor surgeries, emphasizing careful patient selection and monitoring to mitigate BCIS risks.[21] However, data specific to Pakistan are limited, highlighting the need for further research in our local context.

Notably, our study's inclination towards cemented implants is supported by their advantages, such as stress reduction on osteoporotic bones and immediate postoperative stability, which are crucial for the elderly patient population susceptible to hip fractures.[22-24] This is corroborated by the clinical rationale presented by Fernandez et al. and Bökeler et al., who advocate for cemented hemiarthroplasty in mitigating fracture risks and enhancing patient outcomes. [5,10]

As the preference for cemented hemiarthroplasty grows, the implications of BCIS are expected to span a broader patient demographic. Our research emphasizes the critical need for larger BCIS registry datasets across Pakistan to accurately evaluate the prevalence and impact of this potentially manageable complication. Our study's retrospective design and relatively small sample size may limit the generalizability of the findings. Additionally, the reliance on medical records for data collection could introduce information bias, particularly in accurately grading BCIS severity. The absence of standardized protocols for intraoperative monitoring and documentation may also affect the consistency of recorded data. These constraints mirror the challenges faced by Yang et al. in delineating clear causative pathways for BCIS and its varied clinical presentations.[21] Furthermore, our findings emphasize the necessity for heightened vigilance and preoperative assessment in managing patients with significant comorbidities, aligning with precautionary measures suggested in previous studies.[15] Despite these limitations, our study contributes valuable insights into the incidence and impact of BCIS in a Pakistani tertiary care setting. It underscores the importance of recognizing BCIS as a potential complication in cemented hemiarthroplasty and the need for vigilance during perioperative management. To enhance patient outcomes, future research should focus on larger, multicenter prospective studies to better understand BCIS's epidemiology and risk factors in diverse populations. Developing standardized protocols for intraoperative monitoring and management of BCIS, as well as exploring alternative surgical techniques or cementing methods, could mitigate the risks associated with this syndrome. Additionally, increasing awareness and training among surgical and anesthetic teams regarding early recognition and prompt management of BCIS are essential steps toward improving patient safety.

## Conclusion

Our study found a notable incidence of BCIS among patients undergoing cemented hemiarthroplasty for femoral neck fractures. However, the severity of BCIS did not correlate with an increased risk of 30-day mortality.

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**Conflict of Interest**: The authors declare no conflict of interest

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