

# Preexisting dementia is associated with higher mortality rate in patients with femoral neck fracture

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## Abstract

**Objective:** This study aimed to assess the mortality and the influence of age, Abbreviated Mental Test (AMT) scores, and American Society of Anesthesiologists (ASA) grades on patients with dementia and femoral neck fracture (FNF) at 30 days, 4 months, 1 year, and 2 years after undergoing surgery.

**Methods:** Of 1296 patients admitted with FNF, 180 had had prefracture dementia. A retrospective study of these 180 patients was carried out. The patient demographics, including age, sex, presence of diabetes mellitus (DM), lipid profile, AMT score, pre-operative comorbidities, ASA grade, and incidence of postoperative delirium, were documented.

**Results:** A total of 113 patients (62.8%) died postoperatively. The mortality rate was 17.7% (20 patients) at 30 days, 54.9% (62 patients) at 4 months, 77.9% (88 patients) at 1 year, and 87.6% (99 patients) at 2 years. The mortality rate in dementia with FNF was three times higher than that in FNF without dementia and was independent of age, ASA grades, DM, lipid profile, AMT scores, and development of postoperative delirium.

**Conclusions:** Dementia should be a principal predictive factor in mortality of FNF and should be a key determinant in all frailty scores.

## KEYWORDS

dementia, elderly, mortality, femoral neck fracture, prefracture

## 1 | INTRODUCTION

Dementia is one of the major preexisting comorbidities present when a patient is admitted with a femoral neck fracture (FNF). Dementia is a clinical syndrome characterized by progressive decline of brain function, such as cognition, memory loss, thinking speed, mental sharpness, language fluency, judgment, mood swings, movement, and ability to carry out daily activities.<sup>1</sup> Patients with preexisting

dementia are more susceptible to hip fracture due to various risk factors, such as age, decreased activity, sarcopenia, osteoporosis, vitamin D deficiency, and presence of the APOE gene.<sup>2-6</sup> The mortality associated with dementia and FNF was thought to be 2.3 times more than that of patients with intact cognitive function.<sup>7</sup>

The prevalence of dementia in patients aged above 80 years is about 47%.<sup>8</sup> It is predicted that the number of patients with dementia globally will rise to 81 million by 2040.<sup>9</sup> It has been reported that

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85% of hip fractures occur in individuals aged 65 years and older.<sup>10</sup> Patients who suffer from dementia have a higher risk of sustaining hip fractures compared to those who are cognitively competent.<sup>11-13</sup> In patients with Alzheimer's disease (AD), the risk of sustaining an FNF is 2.7 times higher than their sex- and age-matched counterparts without AD.<sup>14</sup> There are also strong relations among cognition, environment, socioeconomic status, and hip fractures.<sup>15</sup>

The aim of this study was to assess the mortality and the influence of age, Abbreviated Mental Test (AMT) scores, and American Society of Anesthesiologists (ASA) grades on patients with dementia at 30 days, 4 months, 1 year, and 2 years after undergoing surgery for FNF.

## 2 | MATERIALS AND METHODS

A retrospective study of 1296 patients admitted with FNF from January 2014 to January 2018 was carried out. After careful scrutiny of all the case notes and the hospital database for FNF admission, we identified 180 patients with dementia who were included in the study. The patient demographics, including age, sex, presence of diabetes mellitus (DM), lipid profile (preoperative LDL levels), AMT score, preoperative comorbidities, ASA grade, and incidence of postoperative delirium, were documented. In the postoperative period, the patients were assessed by a senior orthogeriatrician in the ward.

The diagnosis of delirium was confirmed using *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria (Table 1) and the change from the baseline AMT score was recorded. The mortality rates for 30 days, 4 months, 1 year, and 2 years were analyzed.

### 2.1 | Statistical analysis

The data were analyzed using IBM SPSS Version 25. Categorical data are presented in tables with the number of subjects in each category with the percentages. The categories are also presented in bar charts. Differences between survival and mortality groups were tested using the chi-square test for categorical data and the

**TABLE 1** Diagnostic criteria for delirium according to DSM-IV

A	Disturbance of consciousness (ie, reduced clarity of awareness of the environment) with reduced ability to focus, sustain, or shift attention.
B	A change in cognition (such as memory deficit, disorientation, language disturbance) or the development of a perceptual disturbance that is not better accounted for by a preexisting, established, or evolving dementia.
C	The disturbance develops over a short period of time (usually hours to days) and tends to fluctuate during course of the day.
D	There is evidence from the history, physical examination, or laboratory findings that the disturbance is caused by the direct physiological consequences of a general medical condition.

two-sample *t* test for continuous unpaired data. A *P* value < 0.05 was taken as the threshold of statistical significance. Survival after operation is summarized with a Kaplan-Meier survival curve. Kaplan-Meier curves are presented for different AMT-score groups and ASA-grade groups. The results of the log-rank test are displayed to compare the survival in the AMT-score and ASA-grade groups.

## 3 | RESULTS

The patients' mean age was 87.09 years (range, 64–101 years). There were 40 men and 140 women. Ninety-eight patients (53.8%) had AD, 49 patients (27%) had vascular dementia, and 33 patients (19.2%) had other types of dementia. Ninety-four patients (51%) had more than one comorbidity. The average AMT score was 0.66 (normal range, 0-10) (Table 2).

Eighty patients (44%) were found to have DM (16 insulin-dependent DM and 64 non-insulin-dependent DM). The mortality rate of patients with DM and dementia was 15% (12 patients) at 30 days and 45% (36 patients) at 1 year. The comparative results of all the patients with DM and dementia who survived and died showed no statistical difference (chi-square test: *P* = 0.214).

There were 32 (18%) patients with elevated LDL cholesterol levels preoperatively. The mortality rate for these patients was 13% at 30 days and 25% at 1 year (*P* = 0.185), which is statistically nonsignificant.

There were 43 (24%) patients who developed postoperative delirium. The mortality rate for these patients was 12% (five patients) at 30 days and 25.2% (11 patients) at 1 year. The comparative results of patients who had postoperative delirium and dementia showed no statistical difference (chi-square test: *P* = 0.026).

**TABLE 2** Patient demographics

Variables	Values
Mean age (years)	87.09
Sex	
Male	40 (22.2%)
Female	140 (77.8%)
Dementia	
Total	180
Alzheimer's	98 (53.8%)
Vascular	49 (27%)
Other	33 (19.2%)
Diabetes mellitus	80 (44%)
Elevated lipid profile	32 (18%)
Mean AMT score	0.66 (normal range, 1 to 10)
ASA Grade	
1-2	54 (30%)
3-4	126 (70%)
Postop delirium	43 (24%)

**TABLE 3** Total mortality of the patients with dementia and femoral neck fracture

	Mortality n (%)
Survived	67 (37.2%)
Died	113 (62.8%)
Total	180 (100.0%)

**TABLE 4** Mortality rates at 30 days, 4 months, 1 year, and 2 years after surgery

	Mortality			
	Died < 30 days after operation	Died < 4 months after operation	Died < 1 year after operation	Died < 2 years after operation
Number	20	62	88	99
Percent	17.7%	54.9%	77.9%	87.6%

The total number of patients who died was 113 (62.8%; Table 3). The overall mortality rate was 17.7% (20 patients) at 30 days, 54.9% (62 patients) at 4 months, 77.9% (88 patients) at 1 year, and 87.6% (99 patients) 2 years (Table 4).

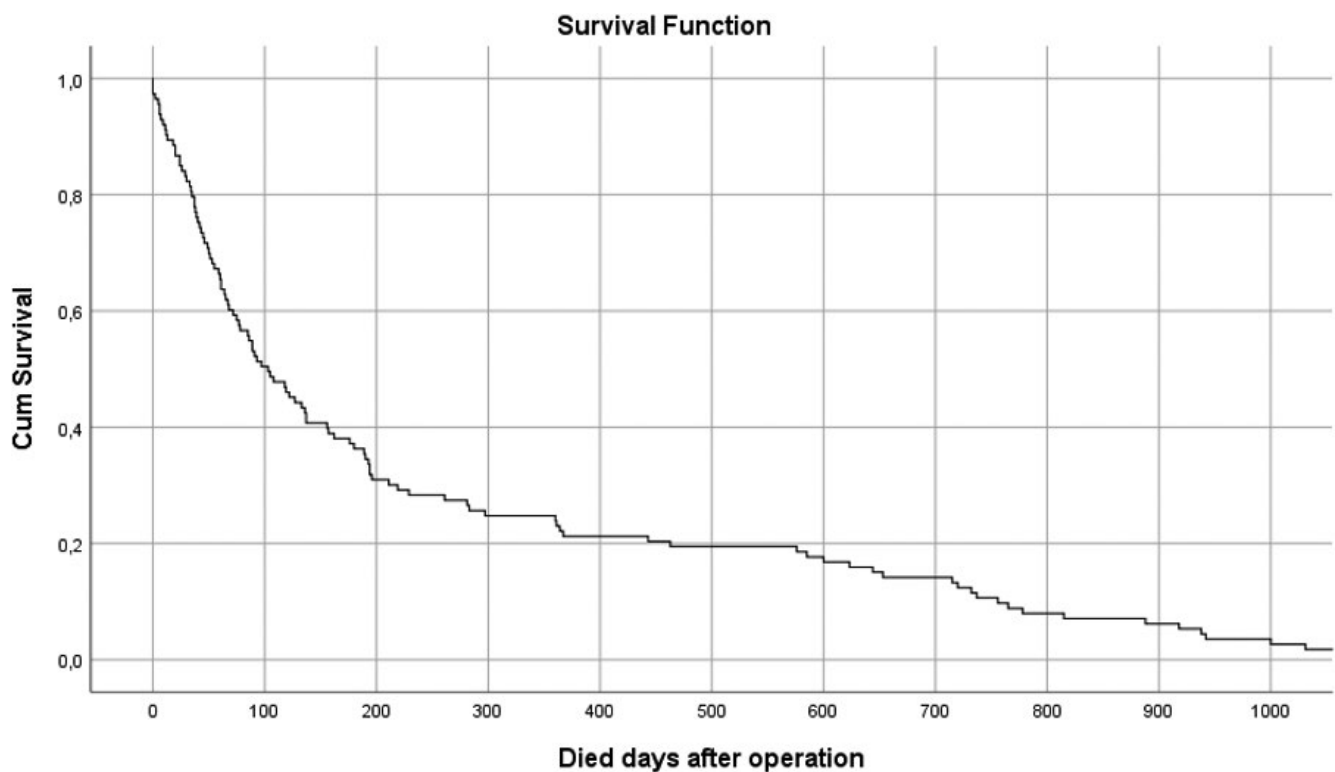
The Kaplan-Meier survival function is illustrated in Figure 1. A comparison of the ages of patients who died and survived after surgery was done using the independent *t* test, which showed no difference ( $P = 0.103$ , 95% confidence intervals for the difference:  $-4.0$  to  $0.37$ ; Tables 5 and 6).

The comparative results of the AMT scores of all the patients who survived and died showed no statistical difference (chi-square test:  $P = 0.263$ ; Figure 2). The Kaplan-Meier survival analysis of the AMT scores of these patients also showed no difference in the survival function (the log-rank test gave  $P = 0.874$ ; Figure 3). The comparative results of the patients with ASA grades of 3-4 and those with ASA grades of 1-2 who survived and died showed no statistical difference (chi-square test:  $P = 0.603$ ; Figure 4). The Kaplan-Meier survival analysis of the ASA grades of these patients also showed no difference in the survival function (the log-rank test gave  $P = 0.207$ ; Figure 5).

## 4 | DISCUSSION

Dementia is the slow and continuous deterioration of mental functions with a median life expectancy of 4.5 years from the diagnosis.<sup>16</sup> Dementia is usually associated with AD, vascular dementia, and Parkinson's disease.<sup>17,18</sup> In our study, 54% of the patients had AD, 27% had vascular dementia, and 19% had other types of dementia. The type of dementia can contribute to varying levels of cognition and frequent falls, which in turn causes hip fractures.<sup>18</sup>

There are several factors that affect both dementia and FNFs. The patient's age is a significant factor that affects both dementia and FNFs.<sup>2,19</sup> The average age in our study was 87 years. In elderly patients, vitamin D deficiency can cause both dementia and fractures.<sup>20</sup> A study by Sutherland et al showed that there is a reduction in the brain's vitamin D receptors in patients with AD.<sup>21</sup> Smoking and

**FIGURE 1** Kaplan-Meier survival curve for patients with dementia after surgery for femoral neck fracture

**TABLE 5** Independent *t* test for the age difference between patients who died and survived

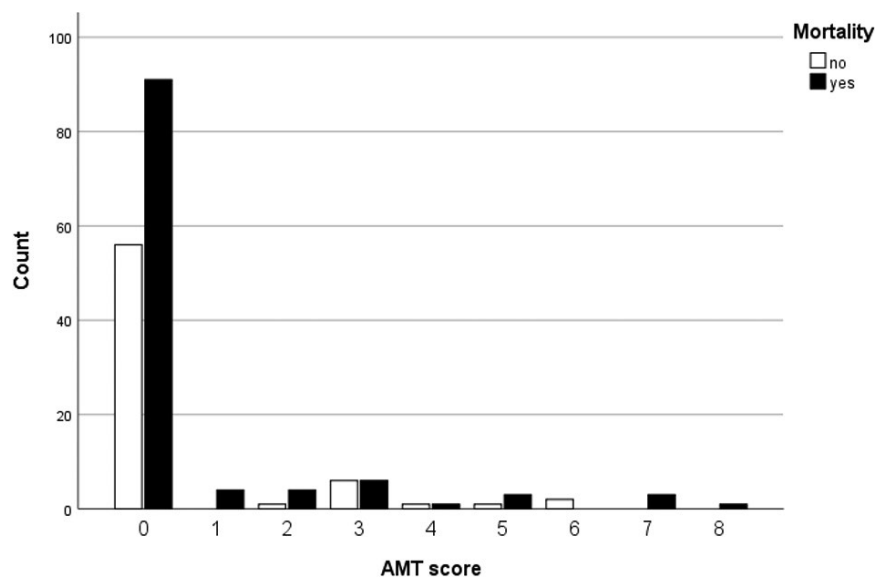
	Mortality	n	Mean	SD
Age (years)	No	67	86.0	7.0
	Yes	113	87.8	7.2

**TABLE 6** Comparison of age in survivors and those who died

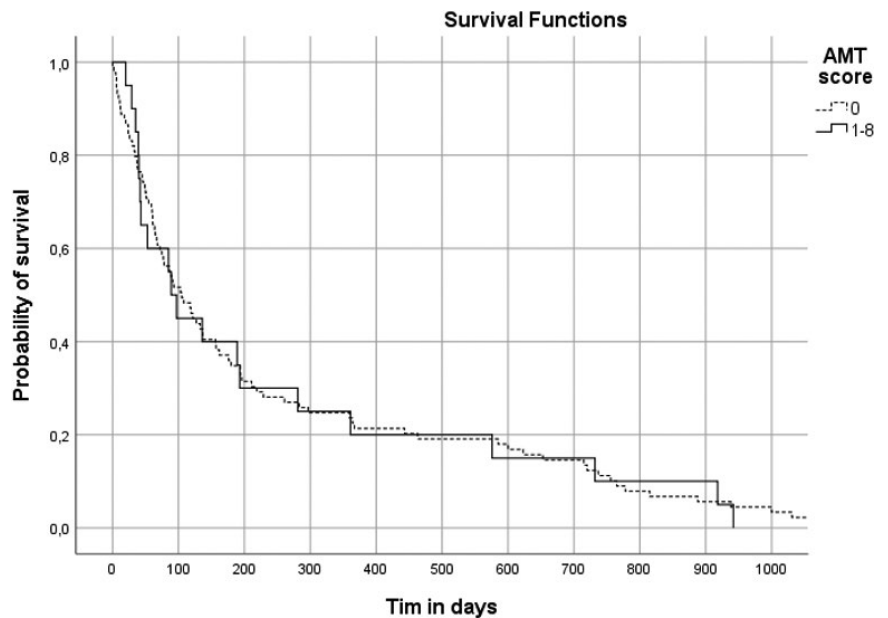
	Mean (standard deviation)		Difference	
	Died (n = 113)	Survived (n = 67)	(95% confidence interval)	P value
Age (years)	86.0 (7.0)	87.8 (7.2)	1.8 (-0.37 to 4.0)	0.103

high levels of alcohol intake are also common risk factors affecting both dementia and hip fractures.<sup>22,23</sup> Both habits causes a reduction in the bone mass leading to hip fractures.<sup>23,24</sup> There is also a strong association between dementia, hip fractures and the presence of the APOE 4 gene.<sup>25</sup>

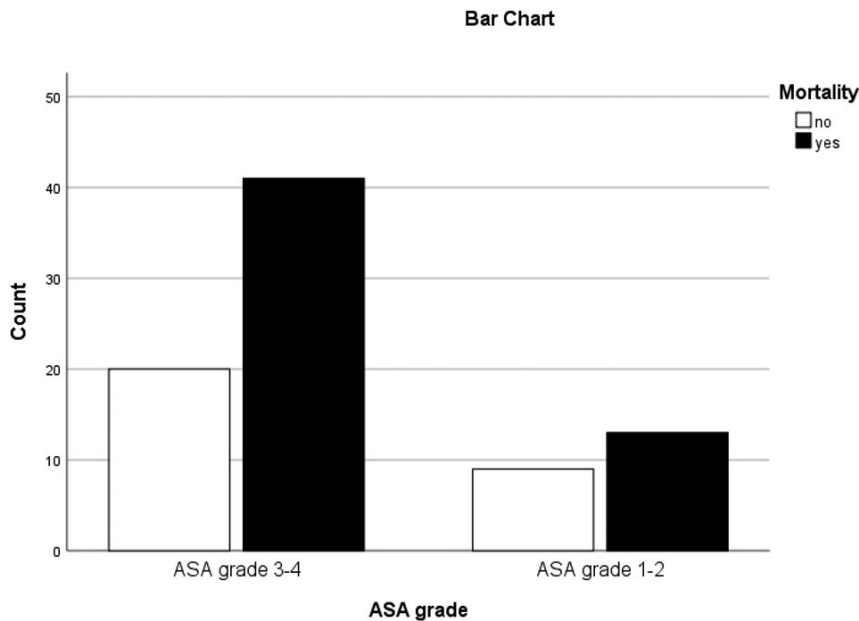
In patients with dementia, there is an eightfold increase in falls which cause hip fractures.<sup>26-28</sup> Patients with dementia due to Parkinson's disease and Lewy bodies have a higher incidence of falls compared to those with AD and vascular dementia.<sup>29</sup> Unsteady gait is an important cause of falls in dementia patients. This is due to the fact that these patients have a prolonged stance phase and a shorter swing phase with decreased stride length and less speed.<sup>30,31</sup> Another reason for increased falls in dementia patients is the prevalence of autonomic dysfunction leading to postural hypotension.<sup>32</sup>



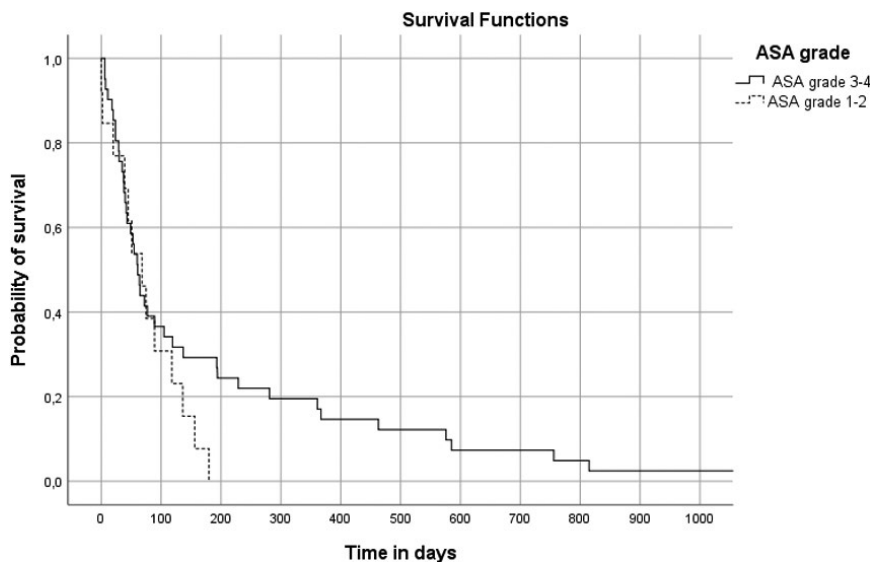
**FIGURE 2** Comparison of survivors and those who died according to Abbreviated Mental Test (AMT) score (chi-square test: *P* = 0.263)



**FIGURE 3** Kaplan-Meier curves comparing Abbreviated Mental Test (AMT) score 0 and AMT scores 1-8, showing that probability of survival did not depend on AMT score (the log-rank test, *P* = 0.874)



**FIGURE 4** Comparison of survivors and those who died according to American Society of Anesthesiologists (ASA) grade 3-4 and ASA grade 1-2 (chi-square test:  $P = 0.603$ )



**FIGURE 5** Kaplan-Meier curves for patients with dementia undergoing femoral neck fracture surgery comparing the American Society of Anesthesiologists (ASA) grades (the log-rank test,  $P = 0.207$ )

A low body mass index is also an important cause of falls in dementia patients resulting in hip fractures.<sup>19,33</sup> Weight loss is a significant and important finding in patients with AD and is usually associated with sarcopenia or reduction in muscle mass.<sup>4</sup> Sarcopenia increases the risk of hip fractures by 1.8-fold.<sup>19</sup> These patients may also suffer from depression, which increases the risk of hip fractures. In a meta-analysis of cohort studies, Wu et al showed that there is an increased risk of hip fractures in depression.<sup>34</sup> Antidepressant medications can cause increased bone loss with higher risk of falls leading to hip fractures.<sup>35,36</sup>

In a meta-analysis, Bai et al showed that the mortality rate in patients suffering from dementia and hip fracture was 12% at 1 month, 32% at 6 months, 39% at 1 year, and 45% after 1 year.<sup>37</sup> In a meta-analysis of 75 studies, Hu et al showed that in patients with dementia and hip fractures, the mortality rate was 13.35% at 1 month, 15.8% at 6 months, 24.5% at 1 year, and 34.5% after 1 year.<sup>38</sup> They

also looked at the various preoperative predictive factors of mortality in hip fracture surgery patients and found that a higher ASA grade indicated a greater likelihood of mortality. In our study, the mortality rate was 17.7% (20 patients) at 1 month, 54.9% (62 patients) at 4 months, 77.9% (88 patients) at 1 year, and 87.6% (99 patients) 2 years. Compared to the previous studies, the mortality rate in our study showed a twofold increase at 1 year; however, this rate was not influenced by the ASA grade.

The AMT score has been used as a predictive factor for the outcomes and mortality rates in FNFs. Krishnan et al concluded that there was a higher rate in mortality with increase in AMT scores.<sup>39</sup> Nandra et al also showed a higher risk of mortality with cognitive decline ( $AMT < 7$ ).<sup>40</sup> Stewart et al concluded that patients with higher AMT scores ( $AMT \geq 7$ ) had better survival rates.<sup>41</sup> Our results showed that the mortality rate was independent of AMT score.

The association between DM and dementia has always been controversial. In a systematic review, Biessels et al suggested that patients with poor glycemic control have an increased risk of developing AD and vascular dementia.<sup>42</sup> Microvascular changes and comorbidities, such as hypertension and stroke, may be contributing factors. In our study, 44% of patients with dementia had DM, but mortality rates in this group were not significantly affected.

In their study on the relation between plasma lipids and dementia, Reitz et al concluded that patients with elevated LDL cholesterol levels were at a high risk of vascular dementia and not AD.<sup>43</sup> In our study, 18% of patients had high LDL cholesterol levels but there was no statistical difference in the mortality at 30 days or 1 year in this group of patients.

FNF patients who had already had a diagnosis of prefracture dementia on admission were significantly more likely to develop postoperative delirium compared with those with no cognitive dysfunction on admission. In their study on risk factors for the onset of delirium after FNF surgery, Tahir et al found that 51% of the patients who developed postoperative delirium had had preexisting dementia; however, there was no statistical difference in the mortality after 30 days or 1 year.<sup>44</sup> This is in full agreement with our study.

#### 4.1 | Limitations of the study

This was a retrospective study involving 180 patients with dementia and hip fractures. The cohort of patients was small and therefore information bias cannot be ruled out.

##### Future directions

A multicenter prospective study with large patient numbers and a longer follow-up period should be carried out in future.

## 5 | CONCLUSIONS

We found that the overall mortality rate in patients with dementia and FNF was 77.9% at 1 year and the perioperative mortality rate was 17.7%. This study shows that the prevalence of prefracture dementia in patients with FNF is a significant factor affecting the mortality rate. Patients with dementia and higher ASA grade did not show increased mortality as compared with those with a lower ASA grade. This was independent of age, preexisting comorbidities, ASA grades, AMT scores, presence of DM, elevated lipid profile, and postoperative delirium. Hence, dementia should be a principal predictive factor in mortality of patients with FNF and should be a key determinant in all frailty scores.

#### CONFLICTS OF INTEREST

Nothing to disclose.

#### AUTHORS CONTRIBUTIONS

Aysha Rajeev contributed to study design, data collection, analysis, and writing of the paper. Mohammed Ali contributed to data analysis

and writing of the paper. Wim Tuinebreijer contributed to writing of the paper. Emadeldeen Zourob contributed to data collection. Joseph Anto contributed to writing of the paper.

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