■ THE HIP SOCIETY

2021 John Charnley Award: A protocol-based strategy when using hemiarthroplasty or total hip arthroplasty for femoral neck fractures decreases mortality, length of stay, and complications

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Aims

While interdisciplinary protocols and expedited surgical treatment improve the management of hip fractures in the elderly, the impact of such interventions on patients specifically undergoing arthroplasty for a femoral neck fracture is not clear. We sought to evaluate the efficacy of an interdisciplinary protocol for the management of patients with a femoral neck fracture who are treated with an arthroplasty.

Methods

In 2017, our institution introduced a standardized interdisciplinary hip fracture protocol. We retrospectively reviewed adult patients who underwent hemiarthroplasty (HA) or total hip arthroplasty (THA) for femoral neck fracture between July 2012 and March 2020, and compared patient characteristics and outcomes between those treated before and after the introduction of the protocol.

Results

A total of 157 patients were treated before the introduction of the protocol (35 (22.3%) with a THA), and 114 patients were treated after its introduction (37 (32.5%) with a THA). The demographic details and medical comorbidities were similar in the two groups. Patients treated after the introduction of the protocol had a significantly reduced median time between admission and surgery (22.8 hours (interquartile range (IQR) 18.8 to 27.7) compared with 24.8 hours (IQR 18.4 to 43.3) (p = 0.042)), and a trend towards a reduced mean time to surgery (24.1 hours (SD 10.7) compared with 46.5 hours (SD 165.0)(p = 0.150), indicating reduction in outliers. Patients treated after the introduction of the protocol had a significantly decreased rate of major complications (4.4% vs 17.2%, p = 0.005), decreased median hospital length of stay in hospital (4.0 days vs 4.8 days, p = 0.008), increased rate of discharge home (26.3% vs 14.7%, p = 0.030), and decreased one-year mortality (14.7% vs 26.3%, p = 0.049). The 90-day readmission rate (18.2% vs 21.7%, p = 0.528) and 30-day mortality (3.7% vs 5.1%, p = 0.767) did not significantly differ. Patients who underwent HA were significantly older than those who underwent THA (82.1 years (SD 10.4) vs 71.1 years (SD 9.5), p < 0.001), more medically complex (mean Charlson Comorbidity Index 6.4 (SD 2.6) vs 4.1 (SD 2.2), p < 0.001), and more likely to develop delirium (8.5% vs 0%, p = 0.024).

Conclusion

The introduction of an interdisciplinary protocol for the management of elderly patients with a femoral neck fracture was associated with reduced time to surgery, length of stay, complications, and one-year mortality. Such interventions are critical in improving outcomes and reducing costs for an ageing population.

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Introduction

Hip fractures are a significant source of mortality, complications, and reduced function.[1-4] Femoral neck fractures, as opposed to trochanteric fractures, represent approximately half of geriatric, low-energy fractures of the hip in the elderly.[5] The choice of surgical management for these fractures is determined by their pattern, the pre-injury functional status and comorbidities of the patient and the experience of the surgeon. Current guidelines of the American Academy of Orthopaedic Surgeons[6] recommend closed reduction and internal fixation for undisplaced femoral neck fractures, and hemiarthroplasty (HA) or total hip arthroplasty (THA) for displaced fractures in elderly patients.

Interdisciplinary standardized programmes and expedited surgical management have been shown to improve outcomes for these patients. Specifically, programmes involving combined orthopaedic and geriatric management have been associated with reduced length of stay (LOS) in hospital,[7-11] complications,[7,9,11-13] readmission,[12] and mortality.[10] Surgical management within 24 hours has also been shown to be associated with decreased complications[14-16] and mortality.[15]

Accomplishing safe, rapid access to the operating theatre for a medically complex group of patients necessitates the co-operation of several disciplines, including emergency medicine, hospital medicine/geriatrics, cardiology, orthopaedic surgery, anaesthesia, and nursing. When considering THA within the management algorithm, it also involves orthopaedic subspeciality care for optimal outcome.[17-19]

To date, there have been no studies which have specifically evaluated interdisciplinary standardized protocols for patients undergoing arthroplasty for a femoral neck fracture. The aim of this study was to compare the outcomes before and after the introduction of an interdisciplinary standardized protocol for the management of elderly patients undergoing HA or THA for a femoral neck fracture.

Methods

Our tertiary care hospital (University of California, San Francisco, USA) introduced a standardized interdisciplinary hip fracture protocol in September 2017. It was designed with contributions and agreement from appropriate representatives of orthopaedic surgery, geriatric and emergency medicine, anaesthesia, cardiology and nursing. The aim of the protocol was to standardize care from the emergency room to 90 days after discharge. Key aspects included optimized non-narcotic multimodal pain control, guidelines for preoperative medical optimization and anti-coagulation management, expedited surgical management including subspecialist availability, combined geriatric and orthopaedic care and post-discharge review by orthopaedics, bone health, and primary care providers (Supplementary Table i). The whole protocol was made available online to all personnel in the care pathway for easy access and reference.[20]

Institutional review board approval was obtained for this study, which was a retrospective review of patients with an acute femoral neck fracture who underwent HA or THA at our hospital between July 2012 and March 2020. Elective admissions were excluded.

The demographic details of the patients and inpatient characteristics, 90-day complications, and mortality up to one year postoperatively after HA and THA were compared before and after the introduction of the protocol. Major postoperative complications were defined using an adaptation of the Centres for Medicare & Medicaid Services/Yale Centre for Outcomes Research and Evaluation risk-stratified complication rate after primary arthroplasty (Table I).[21] In order to avoid bias when determining 30-, 90-, and 365-day outcomes, only patients treated longer than those periods of time, respectively, before the acquisition of data were included.

Statistical analysis. Comparisons were performed with the Student t-test for normally distributed continuous variables and the Wilcoxon rank-sum test for non-normally distributed continuous variables. Fisher's exact test was used to compare categorical variables between groups. Nonparametric results were evaluated by comparing medians. A p-value of < 0.05 was considered significant. All analyses were performed using Stata 13.1 software (StataCorp, USA).

Results

A total of 271 patients were included, 157 who were treated before the introduction of the protocol, and 114 who were treated after it was introduced. The demographic details of the patients including age, sex, and medical comorbidities as measured by the Charlson Comorbidity Index (CCI)[22,23] were not significantly different in the two groups (Table II).

A comparison of those treated before and after introduction of the protocol showed that, independent of the procedure which was performed, the median time from admission to surgery was significantly reduced from 24.8 hours (interquartile range (IQR) 18.4 to 43.3) to 22.8 hours (18.8 to 27.7) after introduction of the protocol ($p = 0.042$, Wilcoxon rank-sum test). The mean time between admission and surgery trended towards a reduction after the introduction of the protocol (46.5 hours (standard deviation (SD) 165.0) before and 24.1 hours (SD 10.7) after, $p = 0.150$, Student *t*-test.) (Figure 1). After the introduction of the protocol, the rate of use of spinal anaesthesia approximately, and patients were significantly more likely to be admitted to

Table I. Major complications, as defined by the Centres for Medicare & Medicaid Services, for primary arthroplasty.

Time period	Complication
During or within seven days of admission	• Acute myocardial infarction • Pneumonia • Sepsis/septicemia/shock
During or within 30 days of admission	• Surgical site bleeding • Pulmonary embolism • Death
During or within 90 days of admission	• Mechanical complications • Periprosthetic joint or wound infection

Table II. Demographic details of the patients treated with hip hemiarthroplasty or with total hip arthroplasty, before and after implementation of the protocol.

Variable	Pre-protocol				Post-protocol				
	HA (n = 122)	THA (n = 35)	All (n = 157)	p-value	HA (n = 77)	THA (n = 37)	All (n = 114)	p-value	Comparable p-value*
Age, yrs, mean (SD)	82.0 (10.8)	71.2 (10.1)	79.6 (11.5)	< 0.001†	82.2 (9.8)	71.0 (9.1)	78.6 (10.9)	< 0.001†	0.488†
Female, n (%)	76 (62.3)	24 (68.6)	100 (63.7)	0.554‡	41 (53.3)	24 (64.9)	65 (57.0)	0.313‡	0.313‡
CCI, median (IQR)	6 (4, 7)	4 (3, 6)	6 (4, 7)	0.0001§	6 (4, 9)	4 (2 to 5)	5 (4, 8)	< 0.001§	0.272§
CCI, mean (SD)	6.3 (2.4)	4.5 (2.3)	5.9 (2.5)	0.0002†	6.6 (2.9)	3.8 (2.0)	5.7 (3.0)	< 0.001†	0.603†

*Comparison in characteristics between before and after protocol implementation, regardless of procedure performed
†Student *t*-test.
‡Fisher's exact test.
§Wilcoxon rank-sum test.
CCI, Charlson Comorbidity Index; IQR, interquartile range; ;SD, standard deviation.

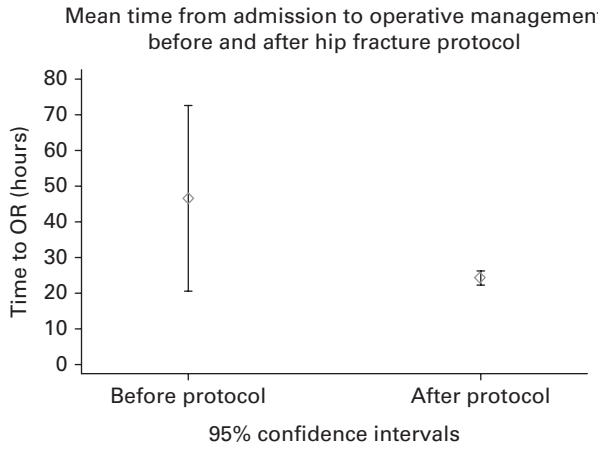

Fig. 1

Average time from admission to surgery: before and after the introduction of the protocol.

the orthopaedic service primarily and to be co-managed with the geriatrics service. Major in-hospital complications occurred in 27 patients (17.2%) before and five (4.4%) after introduction of the protocol (p < 0.001, Fisher's exact test) (Table III). The median LOS was 4.8 days (IQR 3.8 to 6.8) before and 4.0 days (IQR 3.0 to 6.2) after the introduction of the protocol (p = 0.008, Wilcoxon rank-sum test). Patients were significantly more likely to be discharged home with or without social services after the introduction of the protocol. One-year mortality was also significantly reduced from 26.1% to 14.6% (p = 0.049, Fisher's exact test) (Table IV).

There was a trend towards increased use of THA after the introduction of the protocol. Before its introduction, 35 patients (22.3%) were treated with a THA, compared with 37 (32.5%) afterwards (p = 0.071, Fisher's exact test) (Table III). A comparison of all patients treated with HA compared with THA showed that independent of the protocol, those treated with HA were significantly older (p < 0.001, Student *t* test), had a significantly higher CCI (p < 0.001, Student *t* test and Wilcoxon rank-sum test), were significantly more likely to develop delirium (p = 0.008, Fisher's exact test), and were significantly less likely to be discharged home (p < 0.001, Fisher's exact test), than those who underwent THA.

Discussion

An interdisciplinary standardized protocol with expedited surgical management was associated with reduced time to surgery, LOS, complications, and mortality for patients undergoing either HA or THA for a femoral neck fracture. Despite a decreased LOS, there was no concomitant increase in placement to a rehabilitation or nursing facility, increase in the rate of readmission, or increase in medical or surgical complications. These findings are in agreement with those reported for all types of hip fracture in the elderly, rather than specifically for femoral neck fracture.[7–11]

These findings further highlight the importance of the involvement of many specialties for the successful implementation of a protocol to manage these patients.

The reduction in median time to surgery, with a trend towards a reduction in the mean, was mainly due to the decrease in the variation of this time, as seen by the reduction in the IQR from 24.9 to 8.9 hours. The percentage of cases performed within 36 hours of admission increased from 69% before the protocol to 91% after the protocol. Before the protocol, nine (6%) patients were treated more than 72 hours after admission, compared with one (1%) after the introduction of the protocol who was treated 74 hours after admission. These results suggest that before the protocol, most patients with a femoral neck fracture were treated expeditiously, but there were outliers. By standardizing and streamlining the treatment pathway, the protocol may have expedited surgery for the more complex patients, reducing the number of outliers.

Similarly, LOS in hospital was significantly reduced after the introduction of the protocol. As with the reduction in time to surgery, there was a trend toward reduced mean LOS and a significant reduction in median LOS, indicating a reduction in outliers. This is consistent with other studies that have reported a reduction in LOS with an interdisciplinary protocol for hip fractures in the elderly.[7,8,10,11] However, a study that compared patients with a femoral neck fracture undergoing THA within 36 hours or after 36 hours without an interdisciplinary protocol did not show a difference in LOS.[24] This suggests that interdisciplinary protocols play an important role in reducing the LOS.

Importantly, reduced LOS was not associated with increased discharge to a rehabilitation facility; rather, we found a significant increase in patients being discharged home. This is consistent with other studies that showed increased rates of home

Table III. In-hospital characteristics of patients treated before and after the introduction of the protocol.

Variable	Pre-protocol (n = 157)	Post-protocol (n = 114)	p-value
Time from admission to surgery, hrs, mean (SD)	46.5 (165.0)	24.1 (10.7)	0.150†
Time from admission to surgery, hrs, median (IQR)	24.8 (18.4 to 43.3)	22.8 (18.8 to 27.7)	0.042*‡
Spinal anaesthesia, n (%)	25 (17.7)	37 (34.3)	0.011*§
Procedure, n (%)			0.071§
Hemiarthroplasty	122 (77.7)	77 (67.5)	
Total hip arthroplasty	35 (22.3)	37 (32.5)	
Arthroplasty trained surgeon, n (%)			
Hemiarthroplasty	31 (25.4)	32 (41.6)	0.020*§
Total hip arthroplasty	26 (74.3)	28 (75.7)	1.000§
Admission to orthopaedics	66 (42.0)	75 (65.8)	< 0.001*§
Geriatrics comanagement	2 (1.3)	94 (82.5)	< 0.001*§
Cardiology preoperative consultation	2 (1.3)	1 (0.9)	1.000§
Preoperative echocardiogram	50 (31.9)	47 (41.2)	0.124§
Diagnosis of delirium	8 (5.1)	9 (7.9)	0.448§
Major complication, n (%)	27 (17.2)	5 (4.4)	0.001*§
Myocardial infarction	2	0	
Pneumonia	11	2	
Sepsis or shock	5	0	
Surgical site bleeding	0	1	
Pulmonary embolism	1	0	
Death within 30 days	8	4	
Mechanical complication	6	1	
Deep infection	2	0	

*Statistically significant.
†Student *t*-test.
‡Wilcoxon's rank sum test.
§Fisher's exact test.
IQR, interquartile range; ;SD, standard deviation.

Table IV. Discharge characteristics of patients treated before and after the introduction of the protocol.

Variable	Pre-protocol			Post-protocol			
	HA (n = 122)	THA (n = 35)	p-value	HA (n = 77)	THA (n = 37)	p-value	Comparable p-value*
Length of stay, days: mean (SD)	6.1 (4.2)	7.8 (15.1)	0.267‡	5.9 (4.4)	3.7 (1.6)	0.006†‡	0.122‡
Length of stay, days, median (IQR)	4.9 (3.9 to 6.8)	4.0 (3.6 to 6.1)	0.117§	4.9 (3.2 to 7.1)	3.2 (2.5 to 4.1)	0.0005†§	0.008†§
Discharge disposition, n (%)			0.008†¶			< 0.001†¶	0.030†¶
Home, with or without services	12 (9.8)	11 (31.4)		10 (13.0)	20 (54.1)		
Non-home discharge (acute rehabilitation facility or skilled nursing facility)	106 (86.9)	23 (65.7)		66 (85.7)	17 (46.0)		
In-hospital mortality	4 (3.3)	1 (2.9)		1 (1.3)	0 (0)		
90-day readmission	29 (23.7)	4 (14.3)	0.351¶	15 (22.7)††	3 (9.1)††	0.165¶	0.528¶
Mortality, n (%)							
30-day	7 (5.7)	1 (2.9)	0.685¶	4 (5.6)**	0 (0)**	0.301¶	0.767¶
90-day	14 (11.5)	4 (11.4)	1.000¶	7 (10.6)††	1 (3.0)††	0.263¶	0.524¶
One year	35 (28.7)	6 (17.1)	0.197¶	11 (20.4)	1 (3.6)	0.051¶	0.049†¶

*Comparison between before and after protocol implementation, regardless of procedure performed.
†Statistically significant.
‡Student *t*-test.
§Wilcoxon rank sum test.
¶Fisher's exact test.
**Hemiarthroplasty n = 72, total hip arthroplasty n = 35.
††Hemiarthroplasty n = 66, total hip arthroplasty n = 33.
HA n = 54, THA n = 28.
HA, hemiarthroplasty; IQR, interquartile range; SD, standard deviation; THA, total hip arthroplasty.

discharge with interdisciplinary programmes,[12] as well as expedited surgical management.[14] These reductions will decrease costs as days in hospital and rehabilitation facilities are significant sources of expenditure.

A significant reduction in one-year mortality followed the introduction of the protocol. While many other single-centre studies did not report a reduction in mortality associated with hip fracture protocols, some single-centre studies and pooled analyses have done so.[10,25] Our protocol, which extends to the postoperative period, includes appointments for the evaluation of bone health and primary care follow-up which are likely to

contribute to reduced long-term mortality, as these patients are at an increased risk of further fragility fractures.[26]

As also previously described by others, patients in our study who underwent HA were significantly older and more medically complex than those who underwent THA.[27–30] Such demographic differences and procedural selection bias probably explain the increase in the diagnosis of delirium and decrease in rates of home discharge for patients who underwent HA compared with those who underwent THA. The choice of HA or THA is not standardized in our protocol, but is left to the discretion of the surgeon and shared decision-making.

The use of THA for these patients increased after the introduction of the protocol. This may partly be explained by a national trend towards THA compared with HA for femoral neck fractures.[31] Orthopaedic services in our institution (University of California, San Francisco, USA) are structured into teams, with separate teams for trauma and arthroplasty, and most THAs undertaken for a femoral neck fracture are performed by arthroplasty fellowship-trained surgeons. Because both teams are involved in the hip fracture protocol, its introduction improved communication between teams, and increased access to THA for eligible patients; in other words, the availability of an arthroplasty surgeon was less of an impediment.

Limitations of this study include its non-randomized retrospective design, which limits the ability to infer causality of the results from the introduction of the hip fracture protocol. Additionally, outcomes between patients undergoing HA compared with THA are confounded by different risk profiles of these groups. As a single centre study, these findings may not be generalizable to other settings. The introduction of an interdisciplinary protocol may require capital investment that may not be available in all settings, such as smaller hospitals where specialized arthroplasty care or access to geriatric medicine specialists may not be available. Modifications to the protocol may include involving internal medicine physicians rather than geriatricians, partnering with facilities or providers that offer arthroplasty care when indicated, while adhering to the goal of expedited surgery, and using alternative pain management strategies should fascia iliaca blocks be unavailable. Further investigation is warranted to understand how these results may be achieved in other settings.

In conclusion, the introduction of a standardized interdisciplinary protocol was associated with improved outcomes and decreased mortality for patients undergoing arthroplasty for acute femoral neck fracture .

Take home message

- An interdisciplinary protocol with expedited surgical management reduced complications, length of stay, and one-year mortality for patients undergoing hemiarthroplasty or total hip arthroplasty for femoral neck fracture.

Supplementary material

Table showing optimization and anti-coagulation management, expedited orthopaedic surgical management, including subspecialist availability, combined geriatrics and orthopaedics careo-management for geriatric patients, and post-discharge review by appointments with orthopaedics, bone health, and primary care providers.

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S. Rogers: Conceptualized the study, Interpreted the results.
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