■ TRAUMA

The impact of complications on quality of life and mortality after hip fracture

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Aims

There is limited information on how the development of complications influences quality of life (QoL) after hip fracture. The aim of this study was to investigate the relationship between complications, QoL, and mortality after hip fracture.

Methods

The World Hip Trauma Evaluation (WHiTE) study is a multicentre, prospective cohort study that collected data from patients aged ≥ 60 years who received surgical treatment for their hip fracture. Patients were followed up for 120 days after surgery. The primary and secondary outcomes were health-related QoL (EuroQol five-dimension five-level questionnaire; EQ-5D-5L) and mortality, respectively. Linear and logistic regression models were fitted to assess the relationship between complications, EQ-5D-5L, and mortality.

Results

Among 24,523 patients with a hip fracture, the mean differences in EQ-5D-5L in patients who had surgery-specific complications were: prosthesis dislocation -0.14 (95% CI -0.20 to -0.08); fixation failure 0.00 (95% CI -0.15 to 0.14); periprosthetic or peri-implant fracture -0.08 (95% CI -0.18 to 0.02); reoperation for any indication -0.09 (95% CI -0.14 to -0.05); surgical site infection (SSI) -0.06 (95% CI -0.10 to -0.01); and deep SSI -0.13 (95% CI -0.20 to -0.07). The mean differences in EQ-5D-5L for the general complications were: acute kidney injury -0.05 (95% CI -0.07 to -0.02); blood transfusion -0.01 (95% CI -0.03 to 0.01); lower respiratory tract infection -0.07 (95% CI -0.09 to -0.05); urinary tract infection 0.01 (95% CI -0.01 to 0.03); cerebrovascular accident (CVA) -0.17 (95% CI -0.25 to -0.09); myocardial infarction (MI) -0.14 (95% CI -0.20 to -0.08); and venous thromboembolism 0.03 (95% CI -0.02 to 0.08).

Conclusion

We observed worse health-related QoL in patients who had a complication after hip fracture. Those who underwent revision surgery or had a prosthesis dislocation or deep SSI experienced similar levels of disability at 120 days to those with a CVA or MI.

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Introduction

A hip fracture is the most common serious injury in older adults, with over ten million hip fractures occurring worldwide every year.[1] There is substantial disability and mortality that follows the injury, for which the burden of disease is estimated at 27 disability-adjusted life years per 1,000 individuals, equivalent to an average loss of 2.7% of healthy life expectancy.[2-4] The majority of people experience a reduction in mobility and independence after their injury that they never fully regain.[5] Mortality has been the focus of previous hip fracture research, but it is increasingly evident that quality of life (QoL) after hip fracture is a more meaningful outcome.[6,7]

There is a significant decrease in QoL that follows a hip fracture.[8,9] Although a substantial recovery occurs after hip fracture surgery, patients do not tend to fully regain their pre-injury QoL.[8-10] The same factors that influence mortality after hip fracture have also been shown to be associated with QoL, with previous work indicating that higher mortality and lower QoL is observed in patients who develop complications.[8,11] Given

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Table I. Baseline characteristics of the World Hip Trauma Evaluation cohort.

Characteristic	Overall
Patients, n	24,523
Mean age, yrs (SD)	82.9 (8.4)
Sex, n (%)	
Male	7,337 (29.9)
Female	17,186 (70.1)
Regular smoker, n (%)	
Yes	2,139 (8.7)
No	20,958 (85.5)
Missing	1,426 (5.8)
Weekly alcohol consumption, n (%)	
0 to 7 units	20,453 (83.4)
8 to 14 units	1,458 (5.9)
15 to 21 units	507 (2.1)
> 21 units	604 (2.5)
Missing	2,001 (8.2)
Diabetic, n (%)	
Yes	3,603 (14.7)
No	19,566 (79.8)
Missing	1,354 (5.5)
Renal failure, n (%)	
Yes	1,807 (7.4)
No	21,335 (87.0)
Missing	1,381 (5.6)
Cognitive impairment, n (%)	
Yes	7,761 (31.6)
No	15,541 (63.4)
Missing	1,221 (5.0)
Residential status, n (%)	
Own home	13,971 (57.0)
Residential or nursing care	2,463 (10.0)
Rehabilitation unit	86 (0.4)
Acute hospital	85 (0.3)
Other	69 (0.3)
Missing	7,849 (32.0)
ASA grade, n (%)	
I	453 (1.8)
II	5,527 (22.5)
III	13,545 (55.2)
IV	3,546 (14.5)
V	72 (0.3)
Missing	1,380 (5.6)
Fracture type, n (%)	
Femoral neck – undisplaced (B1)	1,647 (6.7)
Femoral neck – displaced (B3)	15,103 (61.6)
Trochanteric – simple (A1)	2,393 (9.8)
Trochanteric – unstable (A2)	3,408 (13.9)
Trochanteric – transtrochanteric (A3)	817 (3.3)
Subtrochanteric	929 (3.8)
Missing	226 (0.9)
Operation type, n (%)	
Sliding hip screw	5,546 (22.6)
Cephalomedullary nail	2,645 (10.8)
Cannulated screws	644 (2.6)
Hip hemiarthroplasty	11,283 (46.0)
Total hip arthroplasty	2,076 (8.5)
Missing	2,329 (9.5)

ASA, American Society of Anesthesiologists.

that the risk of complications is high, preventing these complications is of great importance as this may mitigate the burden of disability.[6,12,13] However, there are few data available on QoL after hip fracture, and how this may be affected by the complications occurring during recovery.[14]

The aim of this study was to investigate the relationship between complications, health-related QoL, and mortality after hip fracture.

Methods

Study design, setting, and participants. The World Hip Trauma Evaluation (WHiTE) study was a multicentre, prospective observational cohort study that collected data on the assessment, treatment, and recovery of a comprehensive hip fracture cohort in England, Wales, and Northern Ireland.[15] Participants were eligible for inclusion if they were aged 60 years or older and received operative treatment for their hip fracture at any of the 77 participating NHS hospitals. On enrolment, patients received treatment under a standardized care pathway based on the National Institute for Health and Care Excellence Hip Fracture Guidelines (CG124).[16] All patients were followed up for 120 days after injury by telephone interviews and postal questionnaires.

Ethics approval. Ethics approval was granted by the London-Camberwell St Giles Research Ethics Committee.[15] This study was registered with the National Institute of Health and Care Research Portfolio (UKCRN ID12351) and the ISRCTN registry (ISRCTN63982700). Written consent to participate in the study was obtained from all patients. Patients who lacked capacity to consent to participate were still included in consultation with their carers.

Data sources. The WHiTE dataset contains data on a core outcome set of patient-reported outcome measures in addition to variables that are routinely measured by the UK National Hip Fracture Database.[17] The full list of variables and outcomes collected as part of the study has been described previously.[15] Data were stored on the OpenClinica v. 3.7 data collection system (OpenClinica, USA).

Variables. The primary variables of interest were the development of surgery-specific and general complications within 120 days of hip fracture. These complications were prespecified and are listed in Appendix A in the Supplementary Material.[12,15] The process of how the data on complications were collected is described in Appendix B. The covariates selected for inclusion in the statistical models were specified a priori and are re-described in detail in Appendix C. The variables considered included patient-related factors such as the patient's demographics, pre-injury health-related quality of life (QoL), comorbidities, and injury, which have previously been shown to explain the variation in mortality and QoL after hip fracture.[8,18,19]

Population. There were 24,523 patients enrolled in the WHiTE study, with complete follow-up available for 22,228 patients (90.6%). The mean age of the overall cohort was 82.9 years (SD 8.4) and 17,186 (70.1%) were female. Surgery-specific and general complications occurred in 1,052 (4.3%) and 4,983 (20.3%) patients, respectively. The baseline characteristics are described in Table I.

Table II. Number and proportion of patients with and without a complication and their respective mean pre-injury EuroQol five-dimension five-level questionnaire (EQ-5D-5L).

Complication	Cohort			Mean pre-injury EQ-5D-5L		
	Yes	No	Proportion (%)	Yes	No	p-value*
Surgery-specific complication						
Prosthesis dislocation	148	13,211	1.1	0.74	0.74	0.670
Fixation failure	78	8,757	0.9	0.79	0.75	0.074
Periprosthetic or peri-implant fracture	77	24,446	0.3	0.56	0.53	0.149
Reoperation for any indication	458	24,065	1.9	0.72	0.74	0.047
Revision surgery	210	24,313	0.9	0.73	0.74	0.426
Reoperation for infection	181	24,342	0.7	0.70	0.74	0.023
Surgical site infection (all)	767	23,756	3.1	0.72	0.74	0.004
Surgical site infection (deep or organ space)	305	24,218	1.2	0.72	0.74	0.059
General complication						
Acute kidney injury	810	23,713	3.3	0.68	0.74	< 0.001
Blood transfusion	1,425	23,098	5.8	0.71	0.75	< 0.001
Lower respiratory tract infection	2,132	22,391	8.7	0.67	0.75	< 0.001
Urinary tract infection	1,609	22,914	6.6	0.69	0.75	< 0.001
Cerebrovascular accident	155	24,368	0.6	0.73	0.74	0.605
Myocardial infarction	171	24,352	0.7	0.70	0.74	0.023
Venous thromboembolism	414	24,109	1.7	0.74	0.74	0.934
Deep vein thrombosis	304	24,219	1.2	0.77	0.74	0.072
Pulmonary embolism	157	24,366	0.6	0.69	0.74	0.020

*Linear regression model.

Outcomes. The primary outcome of interest was health-related QoL, as measured with the EuroQol five-dimension five-level questionnaire (EQ-5D-5L) at 120 days after hip fracture.[20] This is a validated self-administered patient-reported outcome measure that is based on a five-dimension health status classification system and a separate visual analogue scale (EQ-VAS) for overall health state (0 to 100 scale). The responses are converted into an overall score using a published utility algorithm for the UK population.[21] The minimal clinically important difference in EQ-5D-5L is 0.05.[22] The secondary outcome of interest was all-cause mortality during the same period.

Statistical analysis. The baseline characteristics of the study cohort were reported as mean (SD) for continuous measures, and proportions (binary) as appropriate. The cohort was divided into groups according to whether they had a complication or not, for each surgery-specific and general complication. The independent-samples *t*-test was used to compare the pre-injury EQ-5D-5L between these groups. Linear and logistic regression models were used to examine the relationship between each complication, EQ-5D-5L, and mortality, respectively. All models were adjusted for the aforementioned covariates. Death-adjusted EQ-5D-5L was used; patients who died before completing the postinjury EQ-5D-5L were assigned a value of zero.[23] Analyses were conducted on the complete case data (without imputation); only data from patients who completed the baseline and 120-day follow-up for EQ-5D-5L were analyzed. The results are presented as mean differences for the linear regression models and odds ratios (ORs) for the logistic regression models with corresponding 95% CI and p-values. A nominal two-sided 5% significance level was applied throughout. In the primary analysis, the models evaluated the interaction between EQ-5D-5L at the 120-day follow-up or mortality during the 120-day follow-up, and complications within 30 days of follow-up, to minimize distortion of the effect size of the complication by events that may have occurred close to the 120-day follow-up timepoint. In the sensitivity analyses, the interaction between EQ-5D-5L at 120 days of follow-up or mortality during the 120 days of follow-up, and complications occurring at any point during the 120 days of follow-up, was compared. Statistical analyses were performed with R v. 4.2.3 (R Foundation for Statistical Computing, Austria). The EQ-5D-5L utility score was mapped from the five dimensions using the 'eq5d' R package.[24] Linear and logistic regression models were fitted using the 'lme4' R package.[25]

Results

The mean pre-injury EQ-5D-5L was 0.73 (95% CI 0.73 to 0.74) and the mean postinjury EQ-5D-5L at 120 days of follow-up was 0.53 (95% CI 0.53 to 0.54), representing a change of -0.20 (95% CI -0.20 to -0.19). The number and proportion of patients with and without a complication and their respective pre-injury EQ-5D-5L are reported in Table II.

Surgery-specific complications. The adjusted mean difference in EQ-5D-5L in patients who had a surgery-specific complication within 30 days postoperatively is reported in Table III. The change in EQ-5D-5L for a surgery-specific complication was -0.07 (95% CI -0.10 to -0.04; $p < 0.001$); prosthesis dislocation -0.14 (95% CI -0.20 to -0.08; $p < 0.001$); fixation failure 0.00 (95% CI -0.15 to 0.14; $p = 0.969$); periprosthetic or peri-implant fracture -0.08 (95% CI -0.18 to 0.02; $p = 0.111$); reoperation for any indication -0.09 (95% CI -0.14 to -0.05; $p < 0.001$); revision surgery -0.14 (95% CI -0.21 to -0.06; $p < 0.001$); reoperation for infection -0.10 (95% CI -0.16 to -0.03; $p = 0.002$); surgical

Table III. Adjusted mean difference in pre- and post-injury EuroQol five-dimension five-level questionnaire (EQ-5D-5L) for a complication occurring within 30 days postoperatively. Symbols denote the clinical effect size of the change in pre- and post-injury EQ-5D-5L relative to the minimal clinically important difference of 0.05.

Complication	Mean difference (95% CI)	p-value
Surgery-specific complication		
Any surgery-specific complication*	-0.07 (-0.10 to -0.04)	< 0.001
Prosthesis dislocation†	-0.13 (-0.20 to -0.05)	< 0.001
Fixation failure	0.00 (-0.15 to 0.14)	0.969
Periprosthetic or peri-implant fracture	-0.08 (-0.18 to 0.02)	0.111
Reoperation for any indication†	-0.09 (-0.14 to -0.05)	< 0.001
Revision surgery†	-0.14 (-0.21 to -0.06)	< 0.001
Reoperation for infection*	-0.10 (-0.16 to -0.03)	0.002
Surgical site infection (all)*	-0.06 (-0.10 to -0.01)	0.007
Surgical site infection (deep or organ space)†	-0.13 (-0.20 to -0.07)	< 0.001
General complication		
Any general complication*	-0.03 (-0.04 to -0.02)	< 0.001
Acute kidney injury*	-0.05 (-0.07 to -0.02)	0.001
Blood transfusion	-0.01 (-0.03 to 0.01)	0.175
Lower respiratory tract infection†	-0.07 (-0.09 to -0.05)	< 0.001
Urinary tract infection	0.01 (-0.01 to 0.03)	0.454
Cerebrovascular accident†	-0.17 (-0.25 to -0.09)	< 0.001
Myocardial infarction†	-0.14 (-0.20 to -0.08)	< 0.001
Venous thromboembolism	0.03 (-0.02 to 0.08)	0.299
Deep vein thrombosis	0.06 (-0.01 to 0.12)	0.097
Pulmonary embolism	-0.01 (-0.08 to 0.06)	0.773

*Δ EQ-5D-5L (95% CI) < 0.05 | p < 0.05.
†Δ EQ-5D-5L (95% CI) ≥ 0.05 | p < 0.05.

Table IV. Adjusted odds ratio for mortality for a complication occurring within 30 days postoperatively.

Complication	OR (95% CI)	p-value
Surgery-specific complication		
Any surgery-specific complication	1.51 (1.11 to 2.01)	0.007
Prosthesis dislocation	2.01 (1.03 to 3.68)	0.030
Fixation failure*	< 0.01 (N/A)	0.948
Periprosthetic or peri-implant fracture	0.33 (0.05 to 1.11)	0.134
Reoperation for any indication	1.57 (1.04 to 2.31)	0.028
Revision surgery	1.25 (0.56 to 2.51)	0.552
Reoperation for infection	1.78 (1.00 to 3.03)	0.044
Surgical site infection (all)	1.77 (1.22 to 2.52)	0.002
Surgical site infection (deep or organ space)	2.12 (1.20 to 3.57)	0.007
General complication		
Any general complication	1.51 (1.35 to 1.69)	< 0.001
Acute kidney injury	1.76 (1.40 to 2.20)	< 0.001
Blood transfusion	1.05 (0.86 to 1.27)	0.623
Lower respiratory tract infection	2.46 (2.12 to 2.84)	< 0.001
Urinary tract infection	0.82 (0.65 to 1.02)	0.081
Cerebrovascular accident	2.81 (1.51 to 5.02)	< 0.001
Myocardial infarction	5.48 (3.50 to 8.53)	< 0.001
Venous thromboembolism	1.18 (0.67 to 1.96)	0.544
Deep vein thrombosis	0.48 (0.14 to 1.19)	0.164
Pulmonary embolism	1.53 (0.76 to 2.86)	0.201

*Unable to estimate coefficient due to the small number of events across the groups.
N/A, not applicable.

site infection (SSI) -0.06 (95% CI -0.10 to -0.01; p = 0.007); and deep SSI -0.13 (95% CI -0.20 to -0.07; p < 0.001).

The risk of mortality in patients who had a surgery-specific complication within 30 days postoperatively is reported in Table IV. The risk of mortality associated with a surgery-specific complication was 1.51 (95% CI 1.11 to 2.01; p < 0.001); prosthesis dislocation 2.01 (95% CI 1.03 to 2.68; p = 0.030); periprosthetic or peri-implant fracture 0.33 (95% CI 0.05 to 1.11; p = 0.134); reoperation for any indication 1.57 (95% CI 1.04 to 2.31; p = 0.028); revision surgery 1.25 (95% CI 0.56 to 2.51; p = 0.552); reoperation for infection 1.78 (95% CI 1.01 to 3.03; p = 0.044), SSI 1.77 (95% CI 1.22 to 2.52; p = 0.002); and deep or organ space SSI 2.12 (95% CI 1.20 to 3.57; p = 0.007).

General complications. The adjusted mean difference in EQ-5D-5L in patients who had a general complication within 30 days postoperatively is reported in Table III. The change in EQ-5D-5L for a general complication was -0.03 (95% CI -0.04 to -0.02; p < 0.001); acute kidney injury (AKI) -0.05 (95% CI -0.07 to -0.02; p = 0.001); blood transfusion -0.01 (95% CI -0.03 to 0.01; p = 0.175); lower respiratory tract infection (LRTI) -0.07 (95% CI -0.09 to -0.05; p < 0.001); urinary tract infection (UTI) 0.01 (95% CI -0.01 to 0.03; p = 0.454); cerebrovascular accident (CVA) -0.17 (95% CI -0.25 to -0.09; p < 0.001); myocardial infarction (MI) -0.14 (95% CI -0.20 to -0.08; p < 0.001); venous thromboembolism (VTE) 0.03 (95% CI -0.02 to 0.08; p = 0.299); deep vein thrombosis (DVT) 0.06 (95% CI -0.01 to 0.12; p = 0.097); and pulmonary embolism (PE) -0.01 (95% CI -0.08 to 0.06; p = 0.773).

The risk of mortality in patients who had a general complication within 30 days post-operation is reported in Table IV. The risk of mortality associated with a general complication was 1.51 (95% CI 1.35 to 1.69; p < 0.001); AKI 1.76 (95% CI 1.40 to 2.20; p < 0.001); blood transfusion 1.05 (95% CI 0.86 to 1.27; p = 0.623); LRTI 2.46 (95% CI 2.12 to 2.84; p < 0.001); UTI 0.82 (95% CI 0.65 to 1.02; p = 0.081); CVA 2.81 (95% CI 1.51 to 5.02; p < 0.001); MI 5.48 (95% CI 3.50 to 8.53; p < 0.001); VTE 1.18 (95% CI 0.67 to 1.96; p = 0.544); DVT 0.48 (95% CI 0.14 to 1.19; p = 0.164); and PE 1.53 (95% CI 0.76 to 2.86; p = 0.201).

Sensitivity analysis. The results of the sensitivity analysis for EQ-5D-5L and mortality associated with surgery-specific and general complications are presented in Appendix D of the Supplementary Material. The mean differences for EQ-5D-5L and ORs for mortality were similar in both analyses.

Discussion

We observed a clinically meaningful reduction in health-related QoL after hip fracture in this study, equivalent to a decrease in EQ-5D-5L of 0.20. This decline is consistent with reports from previous studies in smaller hip fracture cohorts, where the residual deficit following injury has been found to range between 0.19 and 0.22.[8,26–28] Our findings underline the profound impact that a hip fracture has on mobility, function, and independence in an already frail population. Patients who developed

a complication after hip fracture had a larger decrease in QoL compared with those who did not. Surgery-specific complications had a twofold greater impact on EQ-5D-5L compared with general complications. Much of the decline in QoL we observed in the cohort as a whole could be attributed to one of a small a number of complications. In particular, patients who had a prosthesis dislocation, deep SSI, or revision surgery experienced a similar reduction in QoL at 120 days as those who had a CVA or MI.

Mortality during the follow-up period was 12.4%. It was significantly higher in patients who developed a complication than those who did not. Our analysis identified several complications that were independently associated with excess mortality after hip fracture. The largest effect sizes were observed with general complications; mortality was five times higher in patients with a MI, three times higher in those with a CVA, and two and a half times higher in those with a LRTI. For comparison, mortality was two times higher in patients with a prosthesis dislocation or deep SSI, and one and a half times higher in those who required further surgery for any indication compared with patients with no complication. Studies that have investigated the interaction between mortality and surgery-specific complications such as prosthesis dislocation, SSI, and reoperation have made similar observations, albeit with weaker associations, which can be attributed to the retrospective design, small population size, and incomplete representation.[29–31]

Our findings indicate that the development of complications explains some of the variation observed between patients in QoL and mortality after hip fracture. We have previously observed that the same patient-related factors that influence QoL and mortality also influence the development of complications.[11] As such, these complications are likely to be an important mediating factor in the relationship between patient-, healthcare system-, and treatment-related factors and clinical outcome.[11,19] A number of the complications that have been found to have the largest impact on outcome are potentially preventable.[13] Notably, the risks of revision surgery and prosthesis dislocation are affected by operation type, whereas the risk of MI is influenced by the timing of surgery.[11,13] Preventing such complications will be important in improving outcome after hip fracture.

A key strength of this study is large sample size and the high rate of complete follow-up (> 90%), which allows for examination of relationship between variables. The WHiTE cohort has been shown to be representative of the wider population of hip fractures in the UK and comparable with other populations worldwide.[12,32] We accounted for mortality as part of the reporting of health-related QoL (using death-adjusted EQ-5D-5L); this is because excluding patients who died during follow-up overestimates the true effect size of EQ-5D-5L.[23] There are important limitations that should be considered. The associations identified between complications, QoL, and mortality cannot be taken as proof of a causal pathway per se. While we adjusted for known factors linked to outcomes after hip fracture, it is possible that there are unknown factors that were not accounted for, which might provide a link between hip fractures and QoL and mortality not mediated by complications.

In conclusion, patients who had a complication after hip fracture had worse health-related QoL and mortality than those who did not. Those who had a prosthesis dislocation, deep SSI, or revision surgery experienced similar levels of disability to those with a CVA or MI. Interventions aimed at preventing these complications may improve QoL and reduce mortality after hip fracture and should be the focus of future research.

Take home message

- In the WHiTE study, patients with a complication after their hip fracture had worse quality of life and higher risk of death.
- Patients who had revision surgery, prosthesis dislocation or deep surgical site infection experienced similar levels of disability to those with a stroke or heart attack.

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Supplementary material

List of prespecified complications of interest and of covariates included in the regression models, description of the data collection process for complications, and sensitivity analyses.

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