Lateral wall thickness is not associated with revision risk of medially stable intertrochanteric fractures fixed with a sliding hip screw

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Correspondence should be sent to N. D. Clement
nickclement@doctors.org.uk

B. Chen,[1,2] A. D. Duckworth,[2,3] L. Farrow,[4] Y. J. Xu,[1] N. D. Clement[2,3]

[1]Department of Orthopedics, The Second Affiliated Hospital of Soochow University, Suzhou, China
[2]Edinburgh Orthopaedics, Royal Infirmary of Edinburgh, Edinburgh, UK
[3]Department of Orthopaedics and Usher Institute, University of Edinburgh, Edinburgh, UK
[4]Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, UK

Aims
This study aimed to determine whether lateral femoral wall thickness (LWT) < 20.5 mm was associated with increased revision risk of intertrochanteric fracture (ITF) of the hip following sliding hip screw (SHS) fixation when the medial calcar was intact. Additionally, the study assessed the association between LWT and patient mortality.

Methods
This retrospective study included ITF patients aged 50 years and over treated with SHS fixation between 2019 and 2021 at a major trauma centre. Demographic information, fracture type, delirium status, American Society of Anesthesiologists grade, and length of stay were collected. LWT and tip apex distance were measured. Revision surgery and mortality were recorded at a mean follow-up of 19.5 months (1.6 to 48). Cox regression was performed to evaluate independent risk factors associated with revision surgery and mortality.

Results
The cohort consisted of 890 patients with a mean age of 82 years (SD 10.2). Mean LWT was 27.0 mm (SD 8.6), and there were 213 patients (23.9%) with LWT < 20.5 mm. Overall, 20 patients (2.2%) underwent a revision surgery following SHS fixation. Adjusting for covariates, LWT < 20.5 mm was not independently associated with an increased revision or mortality risk. However, factors that were significantly more prevalent in LWT < 20.5 mm group, which included residence in care home (hazard ratio (HR) 1.84; p < 0.001) or hospital (HR 1.65; p = 0.005), and delirium (HR 1.32; p = 0.026), were independently associated with an increased mortality risk. The only independent factor associated with increased risk of revision was older age (HR 1.07; p = 0.030).

Conclusion
LWT was not associated with risk of revision surgery in patients with an ITF fixed with a SHS when the calcar was intact, after adjusting for the independent effect of age. Although LWT < 20.5 mm was not an independent risk factor for mortality, patients with LWT < 20.5 mm were more likely to be from care home or hospital and have delirium on admission, which were associated with a higher mortality rate.

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Take home message
- Lateral wall thickness was not independently associated with risk of revision surgery in patients with an intertrochanteric fracture fixed with sliding hip screw

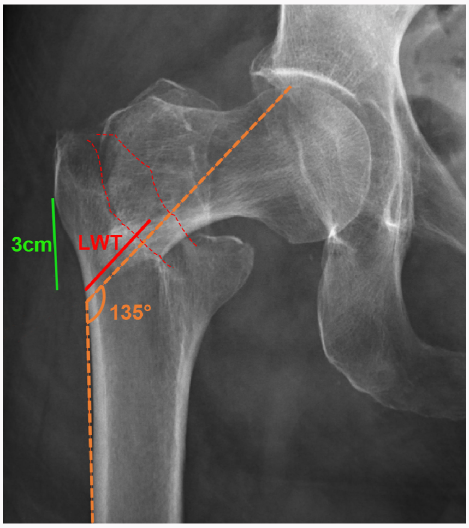

Fig. 1

Lateral femoral wall thickness (LWT) measuring. LWT (red solid line) is determined by measuring the distance from a reference point 3 cm (green line) below innominate tubercle of greater trochanter, using an angled approach of 135° until reaching the fracture line (the mid-line between the two cortex lines (red dashed line)) on anteroposterior radiograph.

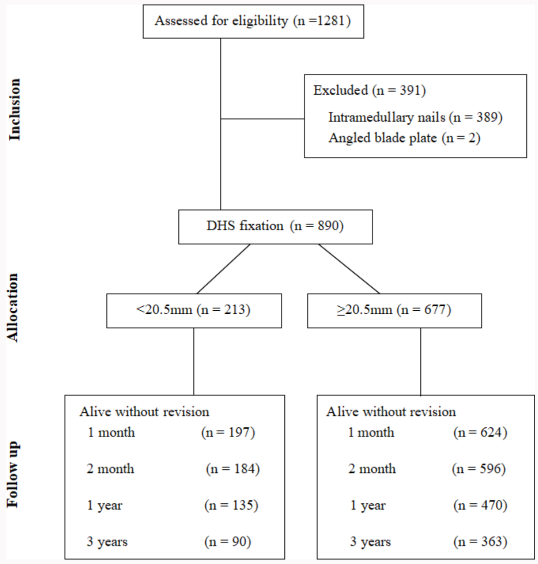

Fig. 2

Participation CONSORT flow diagram.

when the medial calcar was intact, after adjusting for the independent effect of age.

- Patients with a deficienct lateral wall (< 20.5 mm) were more likely to be from care home or hospital and have delirium on admission, which were associated with a higher mortality rate.

Introduction

Hip fractures are a major cause of morbidity and mortality that impose a huge burden on individuals and healthcare systems worldwide. Intertrochanteric fractures (ITF) account for almost half of those patients presenting with a hip fracture and optimal treatment of these, mainly employ extramedullary fixation or intramedullary fixation.[1]

The choice of management is partly determined by the fracture pattern. According to the original AO Foundation/Orthopaedic Trauma Association (AO/OTA) classification, ITF can be classified as 31-A1, 31-A2, and 31-A3 types.[2] The new AO/OTA classification for ITF, published in 2018, redefined 31-A1 and 31-A2 fractures and took the lateral wall thickness (LWT) of proximal femur into account.[3] 31-A1.3 is now defined as a two-part fracture, including an independent lesser trochanter fragment with competent lateral wall (≥ 20.5 mm), while 31-A2 is now defined as fracture including one or more intermediate fragments with incompetent lateral wall (< 20.5 mm). The classification system was updated based on the findings of Hsu et al,[4] who determined that a LWT < 20.5 mm increased the risk of developing a secondary lateral wall fracture when a sliding hip screw (SHS) was employed.

Palm et al[5] initially reported that preoperative or intraoperative fracture of lateral wall was the main predictor for a reoperation after an ITF fixed with SHS. Additionally, Pradeep et al[6] conducted a prospective evaluation of 135 ITF patients fixed with SHS. They concluded that LWT could predict the occurrence of an intraoperative lateral wall fracture and that an intramedullary nail (IMN) may be a superior treatment option compared to SHS, particularly when the LWT measures < 20.5 mm. However, Aros et al[7] observed that patients managed with an IMN had significantly higher rates of revision surgery during the first year than those treated with a SHS (7.2% IMN vs 5.5% SHS). Previous studies, however, did not take into account the effect of the medial calcar, which may influence the risk of revision surgery. Therefore, evaluating the integrity and thickness of the lateral wall, as well as the status of medial calcar, prior to and during surgery, could aid the choice of the optimal implant, especially where there is ongoing debate. Furthermore, to the authors knowledge, the association of LWT and mortality risk have not been assessed; however, ITF are known to be associated with a higher mortality risk when compared to femoral neck fractures.[8]

The primary aim of this study was to validate whether ITF patients with incompetent LWT (< 20.5 mm) had an increased revision risk following SHS fixation when the medial calcar was intact. The secondary aim was to assess whether LWT was associated with patient mortality.

Methods

This retrospective study included all patients aged 50 years or more that were admitted with an ITF to a single university major trauma centre (Royal Infirmary of Edinburgh, UK) over a 36-month period (1 January 2019 to 31 December 2021). The follow-up period started from the date of operation to a maximum of 48 months, or until the time of failure leading to revision surgery or the time of patients' death. In this study, the term 'follow-up' refers to the retrospective evaluation of the time and cases from the surgery until the occurrence of revision surgery or the date of review.

The inclusion criteria were: 1) patients with 31-A1 and 31-A2 ITF and treated with SHS fixation; 2) intact lateral femoral wall in preoperative and intraoperative radiographs; and 3) intact cortex of medial calcar after fracture reduction intraoperatively (see Supplementary figure 1) (i.e. the proximal femoral head-neck fragment is displaced medially to the medial cortex of the femur shaft or the medial cortex of head-neck and the shaft fragment are anatomically contacted in the anteroposterior (AP) radiograph view).[9] The exclusion criteria were: 1) lateral wall fractures or 31-A3 fracture type in preoperative or intraoperative radiographs; 2) unstable medial calcar, namely disruption of the medial calcar, large medial fragment with crack extending beyond 4 cm below the lesser trochanter or poor medial section reduction (i.e. the medial cortex of the head-neck fragment located lateral to the medial cortex of the femur shaft in the AP view;[9] and 3) IMN or other fixation. Intraoperative radiographs were taken throughout the surgery procedure to evaluate the status of medial calcar and integrity of lateral femoral wall.

Patients were retrospectively identified from the local hip fracture database which was collected prospectively on a continuous basis for submission to the Scottish Hip Fracture Audit (SHFA),[10] and was inclusive of all patients. Patient demographics, place of domicile, fracture type, delirium status in ward, American Society of Anesthesiologists (ASA) grade,[11] length of stay (LoS), and mortality was collected from the patients e-health records and service documentation. The data were collected and assessed for completeness by a senior researcher (NDC) as part of the routine activity of the SHFA. All data were handled in accordance with the UK Caldicott principles.

The Scottish Index of Multiple Deprivation (SIMD) was used to assign the socioeconomic status of each patient with assessment of seven domains: current income, employment, health, education, skills and training, housing, geographical access, and crime.[12] The current study used the updated SIMD rankings published in 2020 to assign a patient to a quintile of local data zone deprivations (1= most deprived to 5 = least deprived), according to their postcode at time of injury.

The four "A's" test (4AT) is used internationally as a validated clinical tool for detecting delirium.[13] A score of 4 or more is suggestive of delirium but is not diagnostic. The 4AT is assessed and recorded as part of the "standard" of care for the SHFA on the ward as a screening tool for delirium.

Radiological assessment

Tip apex distance (TAD) was calculated as the sum of the distance from the tip of the lag screw to the apex of the femoral head on both the AP and the lateral postoperative radiographs after controlling for magnification.[14] The lateral wall refers to the lateral cortex of the proximal femur far from the lateral femoral muscle crest. LWT was determined according to the method of Hsu et al,[4] which was defined as the distance in mm from a reference point 3 cm below innominate tubercle of greater trochanter, angled at 135° upwards to the fracture line (the mid-line between the two cortex lines) on AP radiograph (Figure 1). TAD and LWT were measured on the radiographs using digital software (Kodak (USA) picture archiving and communication system on a liquid crystal display).

Outcomes

Acute length of stay (acute LoS) was defined as the number of days between admission to discharge from the trauma centre. Total length of stay (total LoS) was defined as the number of days spent as an inpatient with any service (including rehabilitation facilities) at our centre from the day of admission until eventual discharge or death. Patient mortality status was obtained from the local (study centre) hospital electronic records, which is the sole provider for national healthcare for the catchment population.

Fig. 3

Postoperative radiograph showing lateral wall fracture and cutout of the sliding hip screw from the femoral head into the hip joint.

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software version 25 (IBM, USA). Descript statistics were used to describe the data. Parametric tests were used to assess continuous variables for significant differences between groups (LWT < 20.5 mm vs ≥ 20.5 mm) using an independent-samples *t*-test (age and LoS) were assessed for differences. Categorical variables were assessed using a chi-squared test between group comparisons (sex, fracture type, TAD, rate of revision, mortality, SIMD, ASA grade, pre-fracture residence, and delirium). Kaplan-Meier time to event methodology was used to assess rate of revision and mortality in ITF patients treated with SHS. Log rank (Mantel-Cox) test was used to assess differences in rate of revision surgery between groups (LWT < 20.5 mm vs ≥ 20.5 mm). Cox regression analysis (CRA) was used to assess the independent association of factors influencing rate of revision surgery and mortality when adjusting for confounding variables. A p-value < 0.05 was defined as statistically significant.

Results

There were 1,281 patients with an ITF presenting to the centre during the study period. Of these, 389 were treated with intramedullary nails, and two were treated with angled blade plate. As a result, 391 patients were excluded from our study. Finally, 890 ITF patients (647 females and 243 males) with a mean age of 82 years (standard deviation (SD) 10.2) were included in the study. The consort flow diagram is shown in Figure 2.

Of the 890 ITF, the mean follow-up was 19.5 months (1.6 to 48). During the follow-up period, there were 430 deaths identified. The mean thickness of the lateral femoral wall was

Table I. Univariate analysis of baseline characteristics and risk factors associated with lateral wall thickness between the groups.

Variable	Competent LWT (≥ 20.5 mm; n = 677)	Incompetent LWT (< 20.5 mm; n = 213)	Difference/OR (95% CI)	p-value
Sex, n (% of group)				
Male	189 (27.9)	54 (25.4)	Reference	
Female	488 (72.1)	159 (74.6)	1.14 (0.8 to 1.6)	0.464†
Mean age, yrs (SD)	81.7 (10.3)	82.9 (9.6)	1.16 (-0.41 to 2.72)	0.148‡
Fracture type, n (% of group)				
A1	497 (73.4)	18 (8.5)	Reference	
A2	180 (26.6)	195 (91.5)	29.9 (17.9 to 49.9)	< 0.001†*
TAD, n (% of group)				
≤ 25 mm	613 (90.5)	192 (90.1)	Reference	
> 25 mm	64 (9.5)	21(9.9)	1.05 (0.62 o 1.76)	0.861†
Mean LoS, days (SD)				
Acute	12.9 (10.6)	11.2 (8.2)	-1.66 (-0.1 to -3.22)	0.037‡*
Total	25.7 (20.4)	27.3 (20.2)	1.6 (-1.58 to 4.7)	0.329‡
Revision surgery, n (% of group)	14 (2.1)	6 (2.8)	1.37 (0.52 to 3.62)	0.520†
Mortality	308 (45.4)	122 (57.5)	1.61 (1.18 to 2.19)	0.003†*
SIMD, n (% of group)				
1 (most)	80 (11.8)	34 (16)	1.18 (0.73 to 1.9)	0.509†
2	158 (23.4)	43 (20.2)	0.76 (0.51 to 1.2)	0.264†
3	113 (16.7)	23 (10.8)	0.56 (0.34 to 0.96)	0.033†*
4	116 (17.1)	38 (17.8)	0.92 (0.56 to 1.41)	0.626†
5 (least)	210 (31)	75 (35.2)	Reference	
ASA grade, n (% of group)				
1	13 (1.9)	3 (1.4)	0.71 (0.2 to 2.53)	0.771†
2	126 (18.6)	30 (14.1)	0.73 (0.47 to 1.15)	0.172†
3	366 (54.1)	119 (55.9)	Reference	
4	53 (7.8)	22 (10.3)	1.28 (0.46 to 1.34)	0.373†
Missing	119 (17.6)	39 (18.3)	1 (0.65 to 1.5)	0.970†
Pre-fracture residence, n (% of group)				
Home	514 (75.9)	136 (63.8)	Reference	
Care home	105 (15.5)	50 (23.5)	1.8 (1.22 to 2.65)	0.003†*
4AT, n (% of group)				
Hospital	38 (5.6)	20 (9.4)	1.99 (1.12 to 3.53)	0.017†*
Rehab	12 (1.8)	2 (0.9)	0.63 (0.14 to 2.85)	0.745†
Other	8 (1.2)	5 (2.3)	2.36 (0.76 to 7.34)	0.163†
0 to 3	521 (77)	142 (66.7)	Reference	
4 +	156 (23)	71 (33.3)	1.67 (1.19 to 2.34)	0.003†*

*The difference was significant.
†Chi-squared test.
‡Independent-samples *t*-test.
ASA, American Society of Anesthesiologists; 4AT, four "A's" test; CI, confidence interval; LoS, length of stay; LWT, lateral wall thickness; OR, odds ratio; SIMD, Scottish Index of Multiple Deprivation; TAD, tip apex distance.

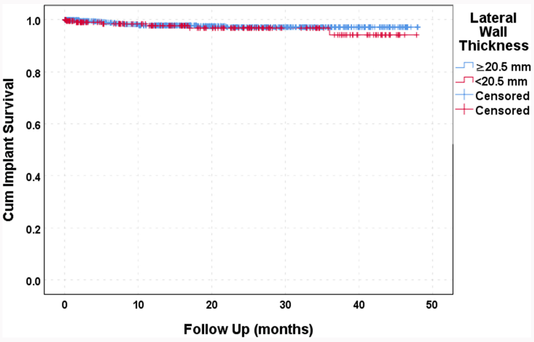

Fig. 4
Kaplan-Meier curves for implant survival according to group (lateral wall thickness); log rank p = 0.646.

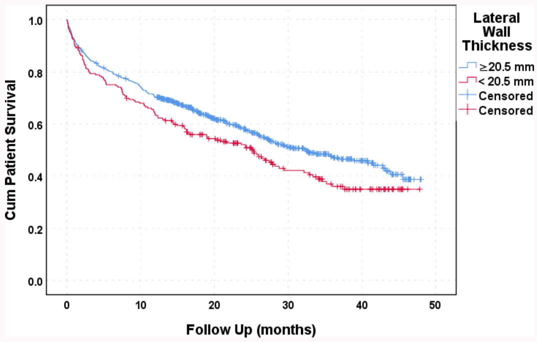

Fig. 5
Kaplan-Meier curves for patient survival according to group (lateral wall thickness); log rank p = 0.022.

Table II. Implant survival follow a intertrochanteric fracture at different timepoints according to group.

	Group survival, % (95% CI)		
Timepoint	**≥ 20.5 mm**	**< 20.5 mm**	**p-value***
30 days	99.8 (99.4 to 100)	99.5 (98.5 to 100)	0.387
60 days	99.5 (98.9 to 100)	99 (97.6 to 100)	0.398
1 year	97.8 (96.6 to 99)	97.7 (95.3 to 100)	0.920
Final follow-up	97.2 (95.6 to 98.8)	94.2 (88.5 to 99.9)	0.520

*Log rank (Mantel-Cox).
CI, confidence interval.

27.0 mm (SD 8.6), and there were 213 patients (23.9%) with LWT < 20.5 mm. Compared to those with competent lateral wall (thickness ≥ 20.5 mm), patients with incompetent lateral wall (thickness < 20.5 mm) were more likely to be classified to 31-A2 fracture type (p < 0.001, chi-squared test), experienced a reduced acute LoS (p = 0.037, independent-samples *t*-test), had a higher mortality rate (p = 0.003, chi-squared test), and were more likely to have a positive 4AT delirium score (p = 0.003, chi-squared test). They were also more likely to be observed in SIMD group 3 (p = 0.033, chi squared test) and admitted from care home (p = 0.003, chi-squared test) or hospital (p = 0.017, chi-squared test). There was no difference in mean TAD or ASA grade between the LWT groups (Table I).

During the follow-up period, a total of 22 patients underwent a revision surgery after SHS fixation. However, we excluded two patients who underwent total hip arthroplasty due to preexisting osteoarthritis after the successful union of ITF fixed with SHS. Ultimately, 20 patients (2.2%) were identified as surgically revised cases after SHS fixation during the follow-up period (Table I). Of these patients, seven had cut out of sliding screw, two had excessive lag-screw back-out, the locking screw broke in one, one had malunion, and one had nonunion. Eight of these patients underwent the revision surgery because of a new fall and subsequent periprosthetic fracture around the implant. In these revised patients above, only two with sliding screw cutout had a combination of lateral wall fracture (Figure 3).

There was no difference in implant survival, at any time point, according to the LWT when comparing those patients with a thickness of < 20.5 mm with those with a thickness of ≥ 20.5 mm (Table II and Figure 4). However, patients with a LWT of < 20.5 mm had a significantly higher mortality rate (unadjusted hazard ratio (HR) 1.28; p = 0.022) when compared to those ≥ 20.5 mm (Table I and Figure 5). When adjusting for confounding factors, LWT of < 20.5 mm was not independently associated with an increased revision risk or mortality rate at the final follow-up (Table III and Table IV). However, factors that were significantly more prevalent in the LWT < 20.5 mm group, which included residence in a care home (HR 1.84; p < 0.001) or hospital (HR 1.65; p = 0.005), and a positive 4AT test (HR 1.32; p = 0.026), were independently associated with an increased mortality risk (Table IV). It is worth noting that older age was found to be independently associated with an increased revision risk after SHS fixation (HR 1.07; p = 0.030) (Table III).

Discussion

This study has shown that a LWT of < 20.5 mm was not associated with an increased revision risk when the medial calcar is intact for 31-A1 and 31-A2 ITF managed with a SHS. There was an association with a significantly increased mortality risk following a ITF in the < 20.5 mm group, but this was not maintained when adjusting for confounding. However, factors that were significantly more prevalent in < 20.5 mm lateral wall group of being resident in a care home or hospital preinjury and having a positive 4AT test on admission were independently associated with an increase mortality risk. The only independent factor associated with increased risk of revision was older age.

Revision surgery for failed internal fixation of ITF is technically challenging due to scaring, altered anatomical

Table III. Cox regression model for variables associated with implant failure at final follow-up following sliding hip screw fixation.

Variable	Hazard ratio	95% CI	p-value
Sex			
Male	Reference		
Female	1.23	0.35 to 4.42	0.747
Age, yrs	1.07	1.01 to 1.15	0.030*
AO classification			
A1	Reference		
A2	2.67	0.89 to 8.01	0.080
Lateral wall thickness			
≥ 20.5 mm	Reference		
< 20.5 mm	0.78	0.25 to 2.49	0.679
TAD			
≤ 25 mm	Reference		
> 25 mm	1.56	0.34 to 7.12	0.565
LoS			
Acute	1.008	0.96 to 1.06	0.762
Total	0.999	0.97 to 1.03	0.937
SIMD			
1 (most)	1.53	0.38 to 6.21	0.551
2	2.37	0.78 to 7.21	0.127
3	N/A		
4	0.76	0.19 to 3.07	0.700
5 (least)	Reference		
ASA grade			
1	N/A		
2	1.22	0.36 to 4.17	0.754
3	Reference		
4	N/A		
Missing	1.07	0.3 to 3.77	0.921
Pre-fracture residence			
Home	Reference		
Care home	0.61	0.11 to 3.44	0.577
Hospital	0.87	0.1 to 7.36	0.896
Rehab	N/A		
Other	N/A		
4AT			
0 to 3	Reference		
4+	0.85	0.21 to 3.45	0.819

*The difference was significant.
ASA, American Society of Anesthesiologists; 4AT, four "A's" test; CI, confidence interval; LoS, length of stay; N/A, not applicable; SIMD, Scottish Index of Multiple Deprivation; TAD, tip apex distance.

Table IV. Cox regression model for variables associated with patient mortality at final follow-up following sliding hip screw fixation.

Variable	Hazard ratio	95% CI	p-value
Sex			
Male	Reference		
Female	0.69	0.56 to 0.86	0.001*
Age	1.05	1.04 to 1.07	< 0.001*
AO classification			
A1	Reference		
A2	1.12	0.89 to 1.43	0.340
Lateral wall thickness			
≥ 20.5 mm	Reference		
< 20.5 mm	1.06	0.8 to 1.36	0.753
TAD			
≤ 25 mm	Reference		
> 25 mm	1.06	0.76 to 1.48	0.735
LoS			
Acute	0.998	0.988 to 1.008	0.704
Total	1.008	1 to 1.01	0.009*
SIMD			
1 (most)	1.14	0.82 to 1.58	0.452
2	1.34	1.03 to 1.74	0.029*
3	1.13	0.83 to 1.53	0.442
4	0.98	0.72 to 1.32	0.868
5 (least)	Reference		
ASA grade			
1	0.3	0.07 to 1.19	0.087
2	0.54	0.37 to 0.78	0.001*
3	Reference		
4	1.73	1.28 to 2.34	< 0.001*
Missing	1.14	0.88 to 1.49	0.325
Pre-fracture residence			
Home	Reference		
Care home	1.84	1.38 to 2.45	< 0.001*
Hospital	1.65	1.16 to 2.34	0.005*
Rehab	1.61	0.86 to 3.03	0.140
Other	0.53	0.17 to 1.68	0.278
4AT			
0 to 3	Reference		
4+	1.32	1.03 to 1.67	0.026*

*The difference was significant.
ASA, American Society of Anesthesiologists; 4AT, four "A's" test; CI, confidence interval; LoS, length of stay; SIMD, Scottish Index of Multiple Deprivation; TAD, tip apex distance.

structure, removal of the failed implant, and subsequent bone loss and defects. The optimal choice of implant for fixation of ITF can not only minimize the potential risk of revision surgery and associated morbidity, but will also be more cost-effective for the healthcare system. The impact of LWT on the implant selection and revision risk in ITF patients is controversial, particularly for AO/OTA 31-A2 fractures. Successful treatment using SHS relies on the reduction and impaction of the head and neck segment of the proximal femur into a stable position, which may promote early healing, a high rate of union, and a low rate of implant failure.[15] In our study, the overall revision rate in competent lateral wall and incompetent lateral wall was 2.1% and 2.8%, respectively, which was consistent with the previously reported 2.2% to 2.6% revision rate.[16,17] The low revision rate in these two groups might be attributed to effective support of the posterior and medial (calcar) region as patients with unstable medial calcar had been excluded in the current study. Medial calcar fragments were considered to be the important elements in determining the implant failure.[18,19] In cases where the medial calcar was unstable, a competent lateral femoral wall (≥ 20.5 mm) may be particularly critical for the mechanical stability of internal fixation. While the medial calcar was restored intraoperatively, incompetent LWT was not a risk factor for revision surgery after SHS fixation. This is consistent with the biomechanical findings from Nie et al,[20] who revealed that compared with the lateral wall, effective medial calcar was more critical to fracture stability following IMN fixation in the intertrochanteric region. Kyle et al[21] reported that the compression strains are significantly larger than the tension strains. SHS is an eccentric fixation system that is typically placed on the tension side of the femur. Compressive stress cannot be transmitted through femur when medial calcar is disrupted, which results in loss of medial support of the fracture and subsequent screw cutout, collapse or lateral wall fracture.[22] The National Institute for Health and Care Excellence (NICE) recommends that SHS should be used in preference to an IMN in people with trochanteric fractures above and including the lesser trochanter for 31-A1 and 31-A2 fractures.[23] Therefore, for those ITF patients with effective medial calcar, SHS may be the preferred implant regardless of lateral wall thickness.

In this study, age was found be an independent risk factor for revision surgery in ITF patients fixed with SHS (HR 1.07). This indicated that there was a 7% increased risk of revision surgery for each additional year of age, which could potentially be attributed to the deteriorating bone quality with age increasing. This is supported by the study from Rha et al[24] that the incidence of excessive sliding/cut out of the lag screw was significantly high in elderly ITF patients fixed with SHS, particularly those aged over 70 years with osteoporosis.

This study has demonstrated that ITF patients with LWT < 20.5 mm had a significantly greater mortality risk (odds ratio (OR) 1.61) at final follow-up. This could be translated into a 60% increased mortality risk compared with LWT ≥ 20.5 mm. We also observed that factors such as care home residence (OR 1.8), hospital residence (OR 1.99), and a positive 4AT delirium screen (OR 1.67) were more prevalent in patients with LWT < 20.5 mm compared with those ≥ 20.5 mm. This suggests that patients with an incompetent lateral wall are likely to be a frailer patient group given the pre-injury residence and delirium risk.[25] When adjusting for confounding factors, LWT was not independently associated with mortality. However, male sex, increasing age, total LoS, more deprived SIMD quintile, increasing ASA grade, care home residence, hospital residence, and positive delirium 4AT delirium screen were all independently associated with mortality. This is consistent with previous studies that have assessed the frailty-related variable, such as increasing age, LoS, comorbidities, pre-fracture residence, and ASA grade, which were demonstrated to be associated with mortality following hip fracture surgery.[26,27] Therefore, it would seem that the patient with an incompetent lateral wall, when defined as < 20.5 mm, are frailer in view of their pre-injury place of residence and delirium risk which are associated with an increased mortality risk.

Limitations of the study include the single-centre retrospective study design, and a prospective cohort study is needed to determine a definite consensus with respect to the effect of LWT on risk of revision surgery following prior failed SHS fixation. Additionally, a biomechanical study is also necessary to assess the relative importance of the medial calcar and lateral wall in the intertrochanteric region after treatment with SHS. Third, bone mineral density was not measured in this study, which might be a contributing factor to the failure of SHS fixation in the ageing ITF patients. Fourth, the study covers a period of three years, hence though all surgeries were performed at a single centre, it was not performed by a single surgeon. However, all surgeons at the centre employ an established strategy for managing these fractures.

In conclusion, age rather than LWT was associated with a risk of revision surgery in patients with an ITF fixed with SHS when the medial calcar was restored intraoperatively. The overall risk of revision surgery for included patients was very low. Therefore, A1 and A2 ITF can be managed with a SHS, in keeping with NICE guideline. However, an IMN may be considered when there is instability or disruption of the medial calcar. Although the LWT is not an independent risk factor for mortality, patients in lateral wall incompetent group were more likely to be from a care home or hospital and have delirium on admission, which were associated with a higher mortality rate.

Supplementary material

Radiograph of: a) intertrochanteric fracture pre-reduction, and b) and post-reduction; and table showing the STROBE statement (checklist of items that should be included in reports of cohort studies).

References

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Author information

B. Chen, MD, Orthopaedic Consultant, Visiting Scholar, Department of Orthopedics, The Second Affiliated Hospital of Soochow University, Suzhou, China;
Edinburgh Orthopaedics, Royal Infirmary of Edinburgh, Edinburgh, UK.

A. D. Duckworth, MSc, PhD, FRCS Ed (Tr&Orth), Senior Clinical Lecturer, Honorary Consultant Orthopaedic Trauma Surgeon
N. D. Clement, MBBS, MD, PhD, FRCS Ed (Tr&Orth), Orthopaedic Consultant, Honorary Clinical Senior Lecturer
Edinburgh Orthopaedics, Royal Infirmary of Edinburgh, Edinburgh, UK; Department of Orthopaedics and Usher Institute, University of Edinburgh, Edinburgh, UK.

L. Farrow, MBChB (Hons), BSc (Intercalated), MRCS, Clinical Research Fellow, Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, UK.

Y. J. Xu, MD, PhD, Orthopaedic Consultant, Department of Orthopedics, The Second Affiliated Hospital of Soochow University, Suzhou, China.

Author contributions

B. Chen: Conceptulization, Data curation, Formal analysis, Methodology, Resources, Writing - original draft.
A. D. Duckworth: Supervision, Writing – review & editing.
L. Farrow: Writing – review & editing.
Y. J. Xu: Writing – review & editing.
N. D. Clement: Conceptulization, Data curation, Methodology, Resources, Writing – review & editing.

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Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

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Ethical review statement

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