



Surgeon grade has a significant impact on short-term postoperative outcomes in hip fracture surgery

Hannah HUGHES, Gerard Anthony SHERIDAN, James STORME, Ursula KELLEHER, Paul CURTIN, CONOR HURSON

From the Department of Trauma and Orthopaedic Surgery, St. Vincent's University Hospital, Dublin, Ireland

Very little is reported on the impact of surgeon grade on hip fracture surgery outcomes. The aim of this study was to investigate the impact of surgeon grade on short-term postoperative outcomes in hip fracture patients.

A Regional Hip Fracture Database (HFD) was analysed over a six-year period. The short-term outcome variables that were assessed included blood loss, postoperative transfusion rates, day-one mobilisation rates, length of stay and the 'cumulative ambulatory score'. Predictor variables included procedure performed, surgeon grade and operative time. The statistical test used was dependent on the variable types. A p-value of less than 0.05 was significant.

In total, 1,593 operative procedures were analysed. The commonest fracture pattern observed was intertrochanteric (n=633, 39.9%). The most common procedures performed were hemiarthroplasty (n=710) and short intramedullary (IM) nail (n=468). Univariate analysis demonstrated that attending surgeons had significantly lower operative times compared to residents (p<0.05). Shorter operative times and procedures performed by attending surgeons were associated with higher rates of day-one postoperative mobilisation (p<0.05). Shorter operative time and surgeon grade were significant predictors of postoperative transfusion rates (p<0.05). Surgeon grade is an important factor that plays a significant role in determining short-term postoperative outcomes for hip fracture patients. Attending

surgeons have shorter operative times, lower rates of postoperative transfusion requirements and higher rates of postoperative day-one mobilisation. We advise that appropriate supervision from experienced attending surgeons is essential to reduce operative times and optimise outcomes for hip fracture patients.

Keywords : Surgeon grade ; resident ; attending ; operative time ; hip fracture surgery ; education, cannulated screws, total hip arthroplasty, intramedullary nail, hemiarthroplasty.

INTRODUCTION

Osteoporotic fractures are an important source of morbidity and mortality for elderly people (aged over 65 years), especially in high-income countries (1). Hip fractures, in particular, place a significant

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- Hannah Hughes,
 - Gerard Anthony Sheridan,
 - James Storme,
 - Ursula Kelleher,
 - Paul Curtin,
 - Conor Hurson.

Department of Trauma and Orthopaedic Surgery, St. Vincent's University Hospital, Dublin, Ireland.

Correspondence : Hannah Hughes, Department of Trauma and Orthopaedic Surgery, St. Vincent's University Hospital, Dublin, Ireland..

Email : h.hughes07@gmail.com

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burden on healthcare systems and society as a whole, due to the associated mortality, disability, need for long-term care and high medical costs (2,3). Furthermore, the incidence continues to increase globally; an estimated 1.6 million hip fractures occurred in 2000, which is expected to rise to 6.3 million by 2050 (4).

The impact of the grade of the operating surgeon on postoperative patient outcomes has been investigated in the literature in various settings. It has been shown that surgeon grade has a significant effect on the 90-day in-hospital mortality rate for patients with lower limb trauma (5). The precise reason for this effect is open to speculation and this study attempts to focus on this relationship. While the impact of operative times on postoperative outcomes in elective orthopaedic procedures has been described, to date, very little is known about the impact of operative times on patient outcomes in hip fracture patients (6-8). Moreover, the relationship between surgeon grade, operative time and short-term outcomes has yet to be described in detail. The aim of this study was to describe the effect that the grade of the operating surgeon and overall operative time can have on short-term outcomes in hip fracture patients undergoing surgery.

MATERIALS AND METHODS

All hip fractures that underwent operative intervention since the establishment of our Regional Hip Fracture Database (HFD) were included in the study. The data for all the relevant variables used in this analysis were recorded from the database. Any patient with an incomplete dataset or any patient receiving treatment before the database was founded were excluded.

A retrospective analysis of our prospectively collected Regional HFD was carried out over a six-year period; from the time of its foundation in 2012 to the date of review. Parameters were collected at the time of patient management and uploaded via electronic means to the database. An orthopaedic clinical nurse specialist ensured prospective maintenance of the database.

Electronic intraoperative anaesthetic records and haematology laboratory records were used to collate

Table I. Cumulative Ambulatory Score

Mobility Level	Score
Bed Mobility	0 – Unable to
Sit to Stand	1 – Able to with assistance of 1 or 2
Mobilisation	2 – Able to with no assistance
	Total Score: 0-6

data for certain parameters that were not recorded on the HFD. These included ‘intraoperative blood loss’ and ‘postoperative transfusion rates’. Individual postoperative transfusion rates were calculated by cross-referencing patient red cell concentrate (RCC) transfusion rates and dates of transfusion with the HFD. A haemoglobin level less than 8 g/dL determined the need for transfusion. The management of perioperative anticoagulation and antiplatelet agents were managed as per best practice guidelines available at the time of the operative intervention.

The major short-term dependant variables analysed were day one postoperative mobilisation rates, length of stay (LOS), the Cumulative Ambulatory Score (CAS) (Table I) (assessed on the first postoperative day and on the day of discharge), blood loss and postoperative transfusion rates. The predictor variables assessed were the type of operative intervention performed, intraoperative time and the grade of the operating surgeon.

Demographics and operative interventions performed were described using descriptive statistics. Analysis of predictive patterns between dependent and independent variables was conducted using univariate analyses. The variable type determined the statistical test that was used. The Kruskal-Wallis statistical test was employed to analyse the predictive effect of categorical variables on interval variables. The chi-squared test was used to assess the associations between two categorical variables, provided the sample had greater than five observations. If there were less than five observations in the observed samples, Fisher’s exact test was used. To assess the predictive effect of operative times on categorical outcomes (e.g. day-one postoperative mobilisation rates), simple logistic regression was used.

In order to control for significant predictor variables that may interfere as confounding variables,

multivariate analysis was performed when significant relationships were identified via univariate analysis. Subgroup analyses were performed when analysing inter-surgeon outcomes, as provisional data analysis observed that surgeon grade had a demonstrable effect on certain outcome variables, including day-one postoperative mobilisation rates, intraoperative times, intraoperative blood loss and postoperative transfusion rates. Statistical analysis was conducted using the statistical software Stata/IC 13.1 for Mac (64-bit Intel). A p-value of less than 0.05 was determined to be significant.

RESULTS

Descriptive

Initially, 1,759 procedures performed for hip fractures were identified over the six-year period ; September 3rd 2012 to July 21st 2018. One hundred and sixty-six patients were excluded from analysis due to insufficient data availability. The remaining cohort consisted of 1,593 patients that underwent operative interventions for hip fractures, with an average age of 81 years of age. The majority of patients were female (73.5%). The American Society of Anesthesiologists (ASA) classification distribution was as follows : Grade 1 (2%), Grade 2 (40%), Grade 3 (45%), Grade 4 (3%), Grade 5 (0.06%), no ASA recorded (9%).

The most common type of fracture pattern observed was intertrochanteric (n=633, 39.9%). The next most prevalent types were displaced intracapsular fractures accounting for 39.7%, followed by undisplaced intracapsular fractures and subtrochanteric fracture types. The commonest procedures performed, in order of descending frequency, were hemiarthroplasty (n=710), short intramedullary (IM) nail (n=468), dynamic hip screw (DHS) (n=206), long IM nail (n=124), cannulated screws (n=51) and total hip replacement (THR) (n=34) (Fig. 1).

For all operative interventions, the mean operative time was 59.3 minutes ($\sigma=27.52$, 9-221). Procedures were performed by the supervising attending surgeon in 61.18% of cases, by trainee residents in 27.4% of cases and in 11.4% of cases



Fig. 1. — Surgical procedures in order of descending frequency.

by staff residents that were not engaged in a formal surgical training scheme.

For all patients in the analysed cohort, the mean length of stay was 23.23 days ($\sigma=45.31$, 1-1227). On the first postoperative day, it was found that 62.5% of patients were mobilised by physiotherapists. The mean cumulative ambulatory score rose from 1.63 ($\sigma=1.61$, 0-6) on the first postoperative day to 3.12 ($\sigma=2.04$, 0-6) on the day of discharge.

Univariate analyses

Hemiarthroplasty

Attendings had significantly lower operative times than trainee residents and staff residents ($p<0.01$) and cases performed by attendings also proceeded to require significantly lower transfusion rates ($p<0.01$). The mean transfusion rate for all procedures was 10.3%. The transfusion rate for attendings was 8%, whilst the rate for trainee residents and staff residents was 14.8% and 11.2%, respectively. The mean operative time was 62.6 minutes ($\sigma=23.33$, 10-202) for all cases. The average length of stay (LOS) was 23 days.

Long Intramedullary Nail

The mean operative time was 84.6 minutes ($\sigma=36.8$, 14-213), with a median blood loss of 500ml. Longer intraoperative times were associated with significantly higher intraoperative blood loss ($p<0.01$). In relation to surgeon grade, attendings were noted to have significantly shorter operative times ($p<0.01$) and lower transfusion rates compared to residents ($p<0.05$). The transfusion rate for attendings was 27.6% for all IM nails, whereas the

transfusion rate for residents was 29%. The average LOS was 28 days.

Short Intramedullary Nail

The mean operative time was 47.8 minutes ($\sigma=22.59$, 9-159), with a median blood loss of 250ml. Shorter intraoperative time was associated with significantly lower intraoperative blood loss ($p<0.05$). The average postoperative transfusion rate for all short IM nail procedures was 22.1%. Higher rates of day-one mobilisation were seen with shorter intraoperative times ($p<0.05$). The average LOS was 23 days.

Dynamic Hip Screw

The mean operative time was 55.9 minutes ($\sigma=20.3$, 12-134), with a median blood loss of 300ml. The average postoperative transfusion rate was 8.4%. There were no significant associations between surgeon grade, intraoperative time, blood loss or transfusion rates in this patient cohort. The average LOS was 19 days.

Cannulated Screws

The mean operative time was 40.1 minutes ($\sigma=22.47$, 12-109). The average postoperative transfusion rate was 5.8% with minimal associated blood loss. There were no significant associations between surgeon grade, intraoperative time, blood loss or transfusion rates for cannulated screw procedures.

Total Hip Arthroplasty (THA)

There were 34 Total Hip Arthroplasties (THAs) performed in total. Twenty-five were cemented and nine were uncemented. The mean operative time was 101.9 minutes ($\sigma=38.5$, 57-212), with a median blood loss of 450ml. The average postoperative transfusion rate for all THA procedures was 17.6%.

Multivariate analysis

The rate of postoperative transfusion for long IM nail procedures had a significant association with

surgeon grade and intraoperative time and was the only outcome variable found to have more than one significant predictor. As a result, a multilevel logistic regression analysis was carried out, which demonstrated that attending surgeons had lower postoperative transfusion rates compared to trainee and non-trainee residents even when controlling for intraoperative time ($p<0.05$). When controlled for surgeon grade, it was found that operative time was not significantly associated with postoperative transfusion rates.

Inter-surgeon analysis

When analysing the grade of the operating surgeon and its effect on postoperative outcomes, we noted that attending surgeons had significantly lower operative times overall when compared to residents ($p<0.05$). The mean operative time for all cases was 58 minutes for attendings, 60 minutes for trainee residents and 62 minutes for staff residents (Fig. 2). Surgeon-specific transfusion rates increased from 14.2% for attendings, to 16.8% for trainee residents, to 17.8% for staff residents. This relationship approached significance only ($p=0.051$). For all cases, shorter operative times were associated with significantly higher rates of day-one postoperative mobilisation ($p<0.05$). It was noted that patients operated on by attending surgeons had a significantly higher rate of day-one postoperative mobilisation also ($p<0.05$).

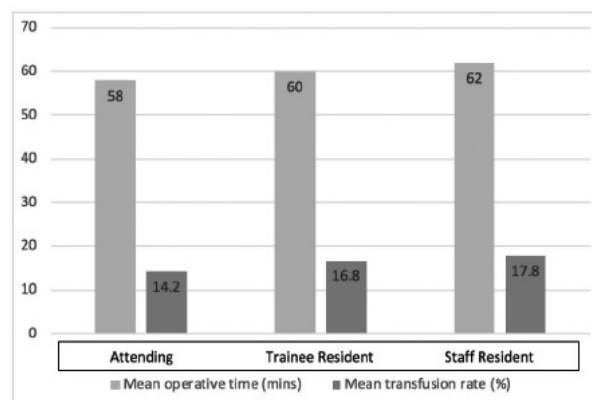


Fig. 2. — Surgeon grade by intraoperative time and postoperative transfusion rate.

DISCUSSION

It has been shown that the grade of the operating surgeon can have significant effects on the outcomes of many orthopaedic interventions. The field of lower limb arthroplasty and the field of trauma surgery have both reported the effect of surgeon grade on a range of postoperative outcomes. Clague et al. report that surgeon grade is a significant predictor of the 90-day in-hospital mortality rate for hip fracture patients (9). In the setting of intertrochanteric hip fractures, Neuwirth et al. found that resident participation was associated with longer operating-room time, longer length of stay and increased time to discharge (10). In general, attending surgeons are more experienced than their trainee residents, with longer times served in clinical practice. A study by Losina et al. demonstrated that, for total hip arthroplasty, high-volume surgeons had lower rates of revision than low-volume surgeons (11). Browne et al. investigated this from a trauma perspective and found that, for hip fracture surgery, low-volume surgeons were associated with higher mortality rates, thereby further indicating that this is a pertinent factor in determining outcomes in patients undergoing surgery for hip fractures (12).

Our results demonstrate some important effects of surgeon grade on a number of short-term outcomes in hip fracture patients undergoing surgery. We found that attending surgeons had significantly lower operative times overall when compared to trainee and staff residents. Patients who had surgery performed by attending surgeons had significantly lower requirements for postoperative blood transfusion. Attending surgeons also had higher rates of day-one postoperative mobilisation.

There is paucity of evidence in the literature pertaining to the impact of surgeon grade on postoperative transfusion rates in hip fracture patients undergoing operative intervention. However, we do know that autologous red cell transfusion is not without risk (13,14). Some studies have shown that postoperative haemoglobin declines were independent of surgeon grade (15). These studies did not describe postoperative transfusion rates as an endpoint however.

We describe the main predictors of transfusion to be operative time and surgeon grade. We found that the rate of postoperative transfusion for long IM nail procedures had a significant association with surgeon grade and operative time. Even after multivariate analysis, attending surgeons had lower postoperative transfusion rates compared to trainee and non-trainee residents, even after controlling for intraoperative time ($p < 0.05$). Attending surgeons had an overall transfusion rate of 14.2% versus 16.8% and 17.8% for trainee and staff residents respectively.

While the impact of operative times on postoperative outcomes in elective orthopaedic procedures has been well described to date, very little is known about the impact of operative times on patient outcomes in hip fracture surgery. In the setting of total knee arthroplasty (TKA), Dicks et al. reported that patients of surgeons with shorter operative times had lower rates of surgical site infection (SSI) (6). Furthermore, Surace et al. reported that, for a cohort of 89,802 total hip arthroplasty procedures, longer operative times were associated with higher rates of SSI, readmission, reoperation and blood transfusion (8). In the setting of trauma surgery, when investigating tibial plateau fractures, Coleman et al. found that the only two predictors of increased infection rates were open injuries and intraoperative time. Most notably, an operative time exceeding three hours in this cohort was associated with higher rates of postoperative complications (16).

The field of lower limb arthroplasty has reported the impact of attending surgeon supervision of trainee resident surgeons during operative procedures, however there is little known about the effect of supervision in the setting of hip fracture surgery. As Reidy et al. suggest, in the setting of hip arthroplasty, when trainee residents performing total hip arthroplasties are supervised appropriately, the results obtained are comparable to those obtained by attending surgeons (17). A study by Turnbull et al. found that in the setting of trauma surgery, the presence of an attending surgeon at the first surgical case on the operating list and at over 50% of cases leads to greater productivity, a higher number of cases performed and reduced turnaround time (18).

Whilst there is still evidence lacking pertaining to the direct effect of attending surgeon supervision of trainee residents during hip fracture surgery, there is evidence here to suggest that improved outcomes may be obtained via improved productivity and work-time.

It has been well demonstrated that surgeon grade plays a significant role in determining postoperative outcomes in both fields of arthroplasty and trauma surgery. Our study further corroborates these findings in relation to hip fracture surgery. Given the effect of surgeon grade on short-term postoperative outcomes in hip fracture patients undergoing surgery, we advise that attending surgeons remain cognisant of their need to provide adequate supervision to trainee and staff residents in order to optimise outcomes in hip fracture surgery.

Our study does have limitations. Intraoperative blood loss of 50ml or less was recorded as 'minimal'. While this may have had an effect on results pertaining to postoperative transfusion rates, it is unlikely to be significant. Another limitation is the fact that a number of patients had an inadequate dataset. The sample size was still significantly large even after excluding these cases and so is unlikely to have any meaningful effect on the results.

Surgeon grade is an important factor that plays a significant role in determining short-term postoperative outcomes for hip fracture patients undergoing surgery. We found that attending surgeons have shorter operative times, lower rates of postoperative transfusion requirements and higher rates of postoperative day-one mobilisation. The grade of the surgeon performing the procedure was the most significant predictor of operative time, even after multivariate analysis. As a result of our findings, we recommend a renewed vigilance around reducing operative times, especially for intramedullary nail procedures. Appropriate supervision from an experienced attending surgeon is essential to reduce prolonged operative times and improve outcomes for hip fracture patients.

REFERENCES

1. **Johnell O, Kanis JA.** An Estimate of the Worldwide Prevalence and Disability Associated with Osteoporotic Fractures. *Osteoporos Int.* 2006 ; 17 : 1726-33.
2. **Papadimitriou N, Tsilidis KK, Orfanos P, Benetou V, Ntzani EE, Soerjomataram I, et al.** Burden of hip fracture using disability-adjusted life-years : a pooled analysis of prospective cohorts in the CHANCES consortium. *Lancet Public Health.* 2017 ; 2 : e239-e46.
3. **Cauley JA.** Burden of hip fracture on disability. *Lancet Public Health.* 2017 ; 2 : e209-e10.
4. **Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, et al.** Secular Trends in the Incidence of Hip and Other Osteoporotic Fractures. *Osteoporos Int.* 2011 ; 22 : 1277-88.
5. **Pugely AJ, Gao Y, Martin CT, Callagh JJ, Weinstein SL, Marsh JL.** The effect of resident participation on short-term outcomes after orthopaedic surgery. *Clin Orthop Relat Res.* 2014 ; 472 : 2290-300.
6. **Dicks KV, Baker AW, Durkin MJ, Anderson DJ, Moehring RW, Chen LF, et al.** Short Operative Duration and Surgical Site Infection Risk in Hip and Knee Arthroplasty Procedures. *Infect Control Hosp Epidemiol.* 2015 ; 36 : 1431-6.
7. **George J, Mahmood B, Sultan AA, Sodhi N, Mont MA, Higuera CA, et al.** How Fast Should a Total Knee Arthroplasty Be Performed? An Analysis of 140,199 Surgeries. *J Arthroplasty.* 2018 ; 33 : 2616-22.
8. **Surace P, Sultan AA, George J, Samuel LT, Khlopas A, Molloy RM, et al.** The Association Between Operative Time and Short-Term Complications in Total Hip Arthroplasty : An Analysis of 89,802 Surgeries. *J Arthroplasty.* 2019 ; 34 : 426-32.
9. **Clague JE, Craddock E, Andrew G, Horan MA, Pendleton N.** Predictors of outcome following hip fracture. Admission time predicts length of stay and in-hospital mortality. *Injury.* 2002 ; 33 : 1-6.
10. **Neuwirth AL, Stitzlein RN, Neuwirth MG, Kelz RK, Mehta S.** Resident Participation in Fixation of Intertrochanteric Hip Fractures : Analysis of the NSQIP Database. *J Bone Joint Surg Am.* 2018 ; 100 : 155-64.
11. **Losina E, Barrett J, Mahomed NN, Baron JA, Katz JN.** Early Failures of Total Hip Replacement : Effect of Surgeon Volume. *Arthritis & Rheumatism.* 2004 ; 50 : 1338-43.
12. **Browne JA, Pietrobon R, Olson SA.** Hip Fracture Outcomes : Does Surgeon or Hospital Volume Really Matter? *J Trauma.* 2009 ; 66 : 809-14.
13. **Kim JL, Park JH, Han SB, Cho IY, Jang KM.** Allogeneic Blood Transfusion Is a Significant Risk Factor for Surgical-Site Infection Following Total Hip and Knee Arthroplasty : A Meta-Analysis. *J Arthroplasty.* 2017 ; 32 : 320-5.
14. **Rohde JM, Dimcheff DE, Blumberg N, Saint S, Langa KM, Kuhn L, et al.** Health care-associated infection after red blood cell transfusion : a systematic review and meta-analysis. *Jama.* 2014 ; 311 : 1317-26.
15. **Rose B, Sindali K, Soueid H, Jeer PJ.** The effect of the grade of surgeon on blood loss in fractured neck-of-femur surgery. *Eur J Orthop Surg Traumatol.* 2013 ; 23 : 449-56.
16. **Colman M, Wright A, Gruen G, Siska P, Pape HC, Tarkin I.** Prolonged operative time increases infection rate in tibial plateau fractures. *Injury.* 2013 ; 44 : 249-52.

- 17. Reidy MJ, Faulkner A, Shitole B, Clift B.** Do trainee surgeons have an adverse effect on the outcome after total hip arthroplasty? : a ten-year review. *Bone Joint J.* 2016 ; 98-b : 301-6.
- 18. Turnbull GS, Hakimi M, McLauchlan GJ.** Trauma theatre productivity - Does the individual surgeon, anaesthetist or consultant presence matter? *Injury.* 2018 ; 49 : 969-74.