Irish Medical Journal
Established 1867

Issue: Ir Med J; Vol 114; No. 1; P234

Intramedullary Nailing and Prolonged Operative Time Increase Transfusion Rates in Hip Fracture Surgery

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Abstract

Aim

The aim of this study was to investigate the impact of intramedullary (IM) nailing on short-term postoperative outcomes in hip fracture patients undergoing surgery.

Methods

All hip fractures that underwent operative treatment over a six-year period were analysed. Variables assessed included blood loss, postoperative transfusion-rates, day-one mobilisation rates, length of stay, procedure performed, operative time and surgeon grade.

Results

In total, 1,593 procedures performed for hip fractures were analysed. The commonest fracture types were intertrochanteric (39.9%, n=633) and displaced intracapsular (37.9%, n=603). The commonest procedures were hemiarthroplasty (44.5%, n=710), short IM nail (29%, n=468) and dynamic hip screw (DHS) (12.9%, n=206). Consultant surgeons performed 61.18% (n=974) of cases. Mean length of stay was 23.3 days (s=45.31, 1-1227). For short and long IM nails, increased operative time led to increased intraoperative blood loss and postoperative transfusion rates ($p<0.05$). Poorer outcomes were associated with short IM nails exceeding 60 minutes and long IM nails exceeding 105 minutes in duration. Surgeon grade was also a significant predictor of postoperative transfusion rates ($p<0.05$).

Conclusion

IM nail procedures lead to higher intraoperative blood loss and postoperative transfusion rates compared to 'non-nail' procedures. We recommend surgeons remain cognisant of optimum operative times for these procedures.

Introduction

Hip fractures place a significant demand on healthcare services and society as a whole [1, 2]. A wide range of procedures are performed on a daily basis to treat these injuries, including intramedullary (IM) nailing. Little is known about the impact of IM nailing procedures on postoperative transfusion rates and hip fracture surgery outcomes. Some studies have shown lower transfusion rates with IM nailing procedures [3]. This has not been the experience of our tertiary referral centre to date. We describe the effect of intramedullary procedures on short-term outcomes in hip fracture surgery and attempt to identify an optimal operative time to reduce postoperative transfusion requirements.

Methods

The aim of this study was to investigate the impact of IM nailing on short-term postoperative outcomes in hip fractures. Secondary aims included identifying the major predictors of postoperative transfusion rates and blood loss in this patient cohort. The inclusion criteria consisted of any hip fracture that underwent operative treatment since the establishment of our National Hip Fracture Database (HFD) in 2012. Exclusion criteria included any patient with an incomplete dataset or any patient receiving treatment before the database was founded. A retrospective review of the National HFD was performed analysing all patients that were treated in our institution over a six-year period, from the establishment of the National HFD to the time of writing.

Certain parameters that were not recorded on the database included 'intraoperative blood loss', which was collected for each case from electronic postoperative anaesthetic records. Transfusion rates of red cell concentrate (RCC) and the dates of RCC unit administration were cross-referenced against the database allowing calculation of individual postoperative transfusion rates. Postoperative transfusions were instituted if the haemoglobin level fell below 8 g/dL. Perioperative anticoagulant and antiplatelet management were controlled by the anaesthetic department as per the best practice guidelines at the time of the procedure.

The dependent variables assessed included intraoperative blood loss, postoperative transfusion rate, day-one mobilisation rates, length of stay (LOS) and the 'cumulative ambulatory score' (CAS), assessed on the first postoperative day and on the day of discharge. Predictor variables included the operation performed, operative-time and surgeon grade.

Descriptive statistics were used to describe the general demographic of the patient cohort, the fracture patterns observed and the procedures that were performed. Univariate analysis was used to assess predictive patterns between independent and dependent variables. The statistical test used was dependent on the variable types. Simple logistic regression was used to analyse the predictive effect of operative time on categorical outcomes. The statistical software used for the analysis was Stata/IC 13.1 for Mac (64-bit Intel). A p-value of less than 0.05 was taken to be significant.

Results

Descriptive

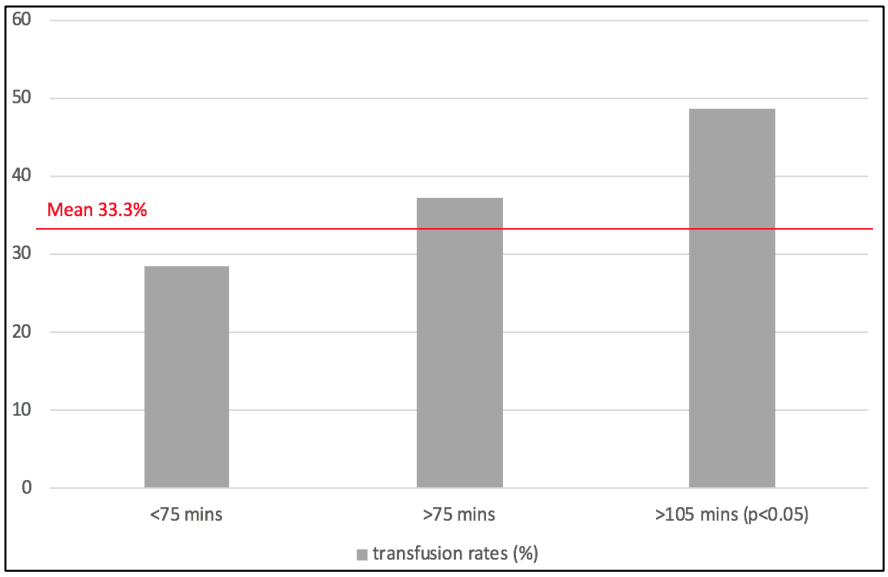
We identified 1,759 procedures performed for hip fractures over a six-year period between September 3rd, 2012 and July 21st, 2018. One hundred and sixty-six did not meet the inclusion criteria. A final patient cohort of 1,593 met the inclusion criteria. The average age was 81 years. The gender profile was 73.5% female and 26.5% male.

The commonest fracture type was intertrochanteric (n=633, 39.9%), followed by displaced intracapsular fractures (n=603, 37.9%). The commonest procedure was hemiarthroplasty (n=710), followed by short 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). The mean operative-time for all cases was 59.3 minutes (σ=27.52, 9-221). The supervising surgeon performed the procedure in 61.18% of cases. A trainee resident performed 27.4% of the cases while the remaining 11.42% were performed by residents that were not actively engaged with a formal surgical training scheme. Physiotherapists mobilised 62.5% of all patients on the first postoperative day. The mean CAS on postoperative day-one was 1.63 (σ=1.61, 0-7) while the mean CAS on the day of discharge rose to 3.12 (σ=2.04, 0-9). The mean length of stay (LOS) for all hip fracture cases was 23.23 days (σ=45.31, 1-1227).

Univariate analyses

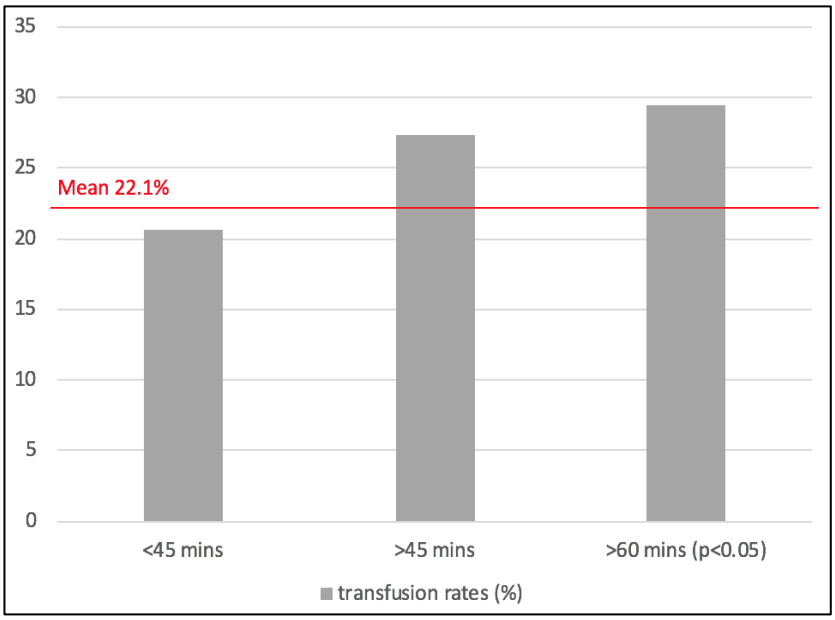
For Long IM Nails, *t*he mean operative-time was 84.6 minutes (σ=36.8, 14-213). There was a 33.3% transfusion rate for all cases with a median blood loss of 500ml. If the procedure lasted less than 75 minutes, the average transfusion rate was 28.5%. If it exceeded 75 minutes, this rose to 37.3%. There was a significantly increased transfusion rate for procedures exceeding 105 minutes in duration ($p<0.05$) (Figure 1). Longer operative times were associated with higher intraoperative blood loss ($p<0.01$).

Figure 1. Transfusion Rates by Operative-Time for Long IM Nails.



For Short IM Nails the mean operative-time was 47.8 minutes (σ=22.59, 9-159). The average transfusion rate was 22.1%. The median blood loss was 250ml with an average LOS of 23 days. Cases under 45 minutes had a rate of transfusion of 20.6% which rose to 27.4% if the operative time exceeded 45 minutes. A significant increase in transfusion rate occurred at 60 minutes where the rate of transfusion rose to 29.4% ($p<0.05$) (Figure 2). Lower operative-times in this cohort were associated with a lower blood loss intraoperatively ($p<0.05$) and a higher rate of day-one mobilisation ($p<0.05$). If the case was under one hour in duration, there was a 48% chance of day-one mobilisation. This dropped to 40% mobilisation when the operative time exceeded one hour.

Figure 2. Transfusion Rates by Operative-Time for Short IM Nails.



The mean operative-time for a hemiarthroplasty was 62.6 minutes (σ= 23.33, 10-202). The median blood loss was 250ml with an average LOS of 23 days. The overall transfusion rate was 10.3%. Procedures under one hour had a transfusion rate of 8.7%, while procedures exceeding one hour had a transfusion rate of 11.8%. The mean operative-time for DHS cases was 55.9 minutes (σ=20.3, 12-134). The median blood loss was 300ml with an average LOS of 19 days. Postoperative DHS transfusion rate was 8.4% on average. The mean operative-time for cannulated screws was 40.1 minutes (σ=22.47, 12-109), with a transfusion rate of 5.8%.

Thirty-four THAs were performed in total. Twenty-five were cemented. The mean operative-time was 101.9 minutes (σ=38.5, 57-212). The median blood loss was 450ml. The overall transfusion rate was 17.6%. Operations performed in under 90 minutes had a transfusion rate of 10.5%. This rose to a transfusion rate of 26.6% if the procedure exceeded 90 minutes. Operations performed in under 90 minutes had a significantly higher rate of day-one mobilisation (<0.05).

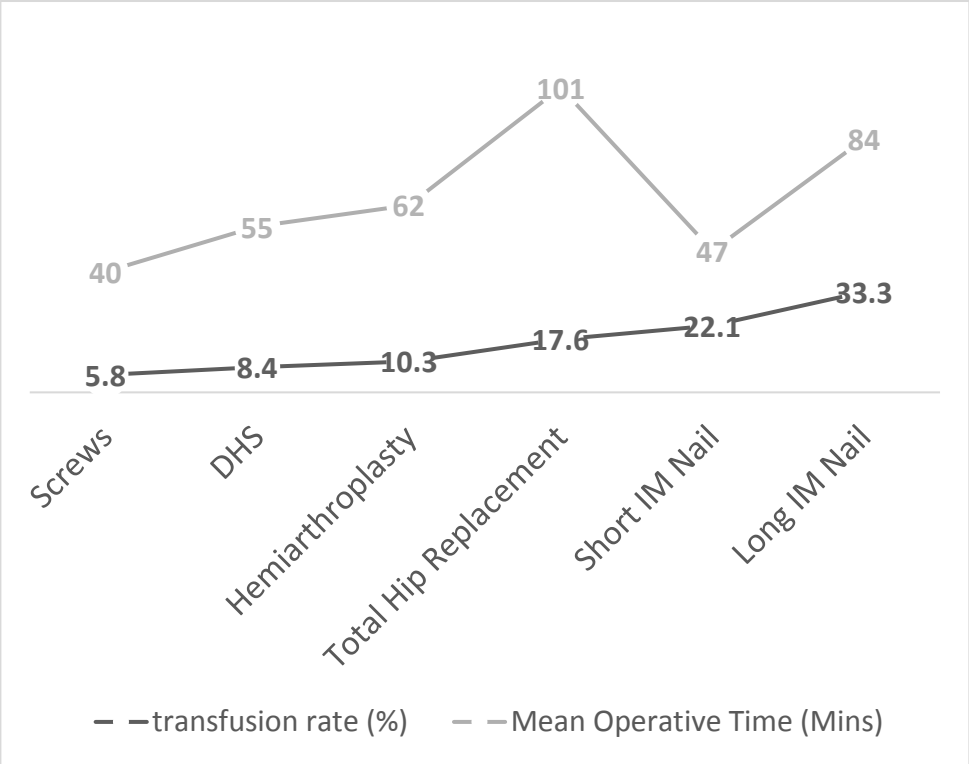
Multivariate analysis

The only outcome variable with greater than one significant predictor was blood transfusion rate in long IM nails, which was significantly associated with both operative-time and surgeon grade. A multilevel logistic regression analysis found that when controlling for operative-time, consultant surgeons still had lower transfusion rates compared to resident surgeons ($p<0.05$).

Inter-procedure analysis

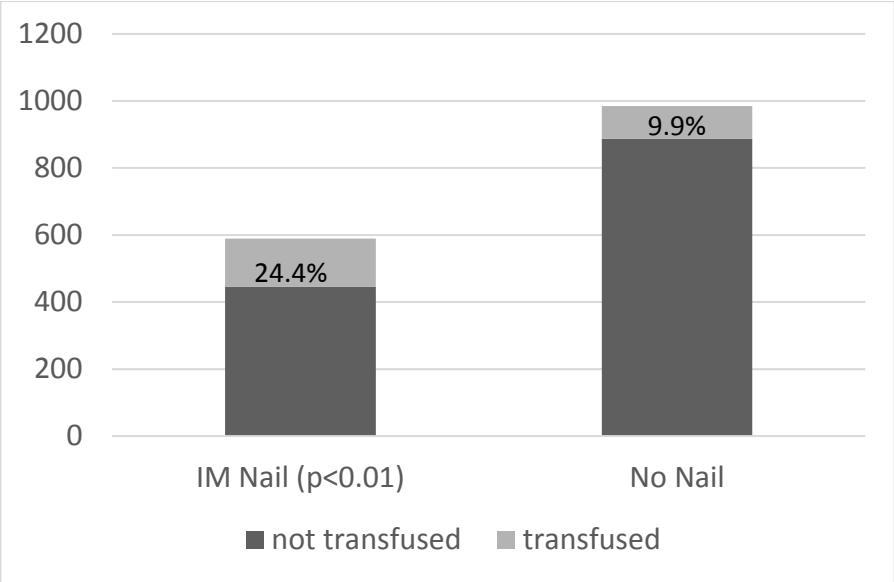
Figure 3 illustrates the mean operative-time and mean transfusion rates for all procedures. Long IM nails had the highest postoperative transfusion rate (33.3%), followed by short IM nails (22.1%). Cannulated screws had the lowest rate of transfusion at 5.8%. Despite the fact that short IM nails were the second quickest procedure to perform, they were associated with the second highest transfusion rate after long IM nails. Long IM Nails had the highest median intraoperative blood loss of all procedures.

Figure 3. Mean Operative-Time and Transfusion Rates for all Procedures.



When comparing IM nail procedures and 'non-nail' procedures, IM nail procedures had a significantly higher postoperative transfusion rate compared to non-nail procedures ($p<0.001$) (Figure 4). Of the 589 IM nails that were implanted, 144 patients were transfused, resulting in a transfusion rate of 24.4%. Of the 985 non-nail procedures, only 98 patients underwent transfusion, resulting in a transfusion rate of 9.9%.

Figure 4. IM Nail vs 'Non-Nail' Transfusion Rates.



Discussion

Operative time can have significant effects on the outcomes of many orthopaedic procedures. The field of arthroplasty has reported the effects of shorter operative times on a range of outcomes. Dicks et al. reported a lower risk of surgical site infection (SSI) in total knee arthroplasty (TKA) patients for surgeons with a lower median operative-time [4]. More recent studies have shown that for TKA, the risk of readmission, reoperation, SSI, wound dehiscence and transfusion are all significantly reduced with reduced operative-time [5]. An operative time of 80 minutes was recommended to reduce complication rates for TKA in this cohort. Surace et al. reported higher rates of readmission, reoperation, SSI, wound dehiscence, systemic complications and blood transfusion in a cohort of 89,802 total hip arthroplasty (THA) procedures when operative-time exceeded 80 minutes [6].

There is little known about the effect of operative time in the setting of trauma. Colman et al. found that for tibial plateau fractures, the only two predictors of increased infection rates were open injuries and operative-time [7]. There is a paucity of evidence in the literature regarding the impact of operative time on hip fracture surgery outcomes. We report a significantly increased intraoperative blood loss and postoperative transfusion rate with increasing operative-time ($p<0.05$) for long and short IM nail procedures. This implies that this specific mode of fixation may incur a higher risk of intra-operative and postoperative bleeding, potentially due to the intramedullary reaming process.

Multiple studies have described an increase in perioperative blood loss and postoperative transfusion rates due to reaming prior to femoral IM Nail insertion [8-10]. We note that short and long IM nails in our cohort had the highest postoperative transfusion rates for all procedures (22.1% and 33.3%, respectively). These results imply that we should view IM procedures as more physiologically invasive than 'non-nail' procedures and should thereby ensure a high level of consultant supervision with an acute awareness of the effect of prolonged operative time.

Operations exceeding 60 minutes for short IM nails and 105 minutes for long IM nails led to a significantly higher risk of postoperative blood transfusion ($p<0.05$). For all procedures, consultant surgeons had lower mean operative-times. Given the effect of operative-time on short term outcomes, particularly for IM nails, we advise close supervision to improve short term outcomes, especially for IM procedures with 'difficult' fracture patterns that are anticipated to require longer operative-times than usual.

Ronga et al. report higher perioperative blood loss rates with Gamma Nails versus dynamic hip screws in trochanteric fractures [11]. These findings comparing Gamma Nails with Dynamic Hip Screws have been replicated in preceding studies also [12]. We report similar findings. Long IM Nails had the highest intraoperative blood loss rates and the highest postoperative transfusion rates at 33.3%, whereas DHS transfusion rates were 8.4%. This strengthens the evidence that intramedullary reaming increases intra-operative blood loss and subsequent postoperative transfusion rates.

Parallels can also be seen when comparing hemiarthroplasty to total hip arthroplasty. Numerous studies have reported that THA incurs a higher risk of postoperative transfusion compared to hemiarthroplasty [13, 14]. We report similar findings, with a transfusion rate of 17.6% for THA compared to 10.3% for hemiarthroplasty. These results are intuitive given the preservation of acetabular bone stock during a hemiarthroplasty and lack of acetabular reaming. We found that for THA, operative-time was a significant predictor of day-one mobility.

Our study had limitations. There were a proportion of patients excluded from analysis due to incomplete datasets. This was due to a lack of comprehensive recording of all parameters pertaining to the HFD in its infancy. This issue has since been addressed and all cases recorded now have fully completed datasets.

IM Nailing procedures lead to significantly higher intraoperative blood loss and postoperative transfusion rates when compared to 'Non-Nail' procedures in hip fracture surgery. In the IM Nail group, prolonged operative-time and surgeon grade led to higher intraoperative blood loss and postoperative transfusion rates. We recommend an operative time of less than 60 minutes for short IM nails and 105 minutes for long IM Nails to reduce postoperative transfusion requirements. We also recommend a renewed vigilance towards the apparent time sensitivity of intramedullary procedures with appropriate supervision from a consultant surgeon at all times.

Declaration of Conflicts of Interest:
The authors declare that there are no conflicts of interest.

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