Convergence of Outcomes for Hip Fracture Fixation by Nails and Plates

Foster Chen BS, Zhong Wang PhD, MPH,
Timothy Bhattacharyya MD

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Abstract

Background Recent popularity of intramedullary nails over sliding hip screws for treatment of intertrochanteric fractures is concerning given the absence of evidence for clinical superiority for nailing yet the presence of reimbursement differences.

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This work was performed at the National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, Bethesda, MD, USA.

F. Chen
University of California, San Diego School of Medicine,
La Jolla, CA, USA

F. Chen, Z. Wang, T. Bhattacharyya (✉)
National Institutes of Health, 10 Center Drive, Mail Code 1468,
Bethesda, MD 20892-1150, USA
e-mail: timothy.bhattacharyya@nih.gov;
tbhattacharyya@mail.nih.gov

Questions/purposes We describe the change in outcomes of both procedures across a 15-year span and address the role of reimbursements in the setting of shifting patterns in use.

Methods A 5% sample of Medicare enrollees from 1993 to 2007 was used. Cohorts were generated along diagnostic and procedure codes. Trends in device use by hospital type, surgical times, and rate of revision surgeries were compared. Historic reimbursements were examined.

Results Since 2005, intramedullary nail fixation has become the more common treatment in government, non-profit, and for-profit hospitals. Before 1999, intramedullary nailing required 36 minutes longer to perform than plate-and-screw fixation on average, and had higher revision surgery rates (hazard ratio, 2.48; CI, 1.37–4.48) and 1-year mortality (hazard ratio, 1.42; CI, 1.01–1.99). These differences were not significant since 2000. Reimbursement differences have been consistently in favor of intramedullary nails.

Conclusion Intramedullary nailing of intertrochanteric fractures has become as safe and efficient as the sliding hip screws, but has been more popular since 2006. Reimbursements were favorable for intramedullary nails in times of low and high use. These results argue against the reimbursement difference as the sole driving force for use of intramedullary nails.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

For the past two decades, intramedullary nails (or cephalomedullary nails) have been available as an alternative to

plate-and-screw type fixation for intertrochanteric hip fractures. The results of randomized controlled studies have been contradictory with one study showing that intramedullary nails are equivalent to plate-and-screw devices [4] and another reporting a possible higher complication rate with intramedullary nails [3]. One study documented a dramatic change in patterns in training [2] and practice, and from 2000 to 2002, the rate of nail use for treatment of intertrochanteric fractures has doubled [8].

The etiology of this rapid shift in practice is not known but is concerning given the conflicting evidence in the current literature. The most recent Cochrane review concluded that sliding hip screws were associated with decreased rates of secondary fracture and reoperation [14], and in the absence of clear evidence of clinical superiority for intramedullary nails, some authors have speculated that the reimbursement difference between the two procedures is the likely cause of the shift [2, 8]. However, a separate meta-analysis compared the results of studies regarding one popular nail design before and after 2000 and found that although studies based on early designs led to higher risks of complications, they were resolved when considering only more recent studies [5]. Previous studies showed that government-owned hospitals tend to be less apt to perform costly surgical procedures for the hospital and tend to offer services to patients with lesser regard to revenue [17], whereas for-profit hospitals are more likely to use newer technologies as a form of competition [9]. One might hypothesize that for-profit-hospitals, for the reasons mentioned above, might use nailing technologies at a different rate from other hospitals.

Although observed for one line of devices, it remains to be shown if intramedullary nail outcomes have improved as a class. In this study, we took an epidemiologic approach to study this shift in practice using a 5% Medicare sample from 1993 to 2007. We hypothesized that outcomes and efficiency of nailing improved at approximately the time of its increased use, and higher reimbursement for nailing would expedite its use at a different pace across hospitals with different cost structures.

Patients and Methods

We obtained the Medicare 5% sample from the Surveillance, Epidemiology and End Results (SEER) regions minus any patients with any cancer diagnosis according to SEER registry, to eliminate most pathological fractures related to cancer [11]. This data set contains longitudinal billing data on Medicare beneficiaries in the United States, ranging from 291,832 individuals in 1993 to 485,115 individuals in 2005. We identified patients who sustained a hip fracture by the International Classification of Diseases,

Table 1. Characteristics of Medicare beneficiaries

Parameter	Number (%)	
	Plate-and-screw (n = 6931)	Intramedullary nail (n = 1993)
Gender		
Male (number/%)	1349 (19%)	426 (21%)
Female	5582 (80.5%)	1567 (78%)
Age, years (mean/SE)	84 (0.1)	83 (0.2)
Race		
White	6405 (92%)	1824 (92%)
Black	187 (3%)	62 (3%)
Other	339 (5%)	107 (5%)
Charlson comorbidity score		
0	3638 (53%)	947 (48%)
1	2146 (31%)	640 (32%)
2	722 (10%)	245 (12%)
≥ 3	425 (6%)	161 (8%)

SE = standard error.

9th diagnosis code of 820.XX and further by Current Procedural Terminology (CPT) codes for treatment by plate-and-screw device (27244) and intramedullary nail device (27245). A total of 8924 patients with 1-year followup data were identified between 1993 and 2007. Demographic distributions were similar between the two groups (Table 1). We collected data on age, sex, comorbidity, and census region for each patient.

We studied complications after hip fracture fixation by identifying patients who had returned to the operating room within 365 days after their initial procedure. Complications such as conversion to hip arthroplasty, removal of hardware, and nonunion surgery were identified by CPT code [3]. One-year mortality also was captured among these patients. Because of the introduction of several devices near the turn of the millennium, we stratified the cohort into two: for 1993 to 1999 and 2000 to 2007.

We calculated the percentage of intertrochanteric fractures treated by nails or plates for each calendar year and compared the proportions of treatments performed in government-owned hospitals with nonprofit and for-profit hospitals.

We calculated the anesthesia time and surgical time using anesthesia billing claims. This method was described by Silber et al. [16]. The appropriate anesthesia codes for our study began with 011 and 012 and represented anesthesia administered for procedures of the pelvis and upper leg, respectively. Surgical times were estimated by the following equation: surgical time = $(0.82 \times \text{anesthesia time} \times 23.81)$. This equation was the result of linear regression models for anesthesia times on various

orthopaedic procedures [8]. The median surgical times for each year were plotted.

Finally, we calculated the mean reimbursements provided to the physician by Medicare for each procedure between 1993 and 2007. This value was taken to be the amount paid by Medicare and any deductibles owed the patient. In cases in which multiple payments were filed, the largest single payment was taken to be the amount reimbursed for the actual procedure. We also compared the intended reimbursement from the total relative value units (RVU) recorded annually for these two procedures for each year from records from the federal register.

Trends of use were descriptive. The adjusted Cox proportional hazards model was used to generate Kaplan-Meier survival curves and hazard ratios for complication and mortality rates. Covariates included age (65–69, 70–74, 75–79, 80–84, 85–89, 90+ years), race (white, nonwhite), sex, and Charlson comorbidity index (0, 1, 2, 3+). Median surgical times were plotted for each year, whereas mean surgical times with 95% CIs were calculated for 1993 to 1999 and 2000 to 2007 for both procedures. Mean reimbursements for each year were adjusted to 2007 values according to the Consumer Price Index for each year and procedure.

Results

After 2000 adverse outcomes associated with the use of intramedullary nails were less frequent and the results became similar to those for plates and screws. From 1993 to 1999, complications were 2.48 times more likely (95% CI, 1.37–4.48) to occur in patients treated with an intramedullary nail than in patients treated with a plate-and-screw device (Fig. 1). However, from 2000 to 2007, there was no increased risk of complications between the two procedures (hazard ratio, 1.11; 95% CI, 0.82–1.51). From 1993 to 1999, 1-year mortality was slightly higher for individuals treated with an intramedullary nail as well (hazard ratio, 1.42; 95% CI, 1.01–1.99). From 2000 to 2007, there was no difference in mortality between the two groups (hazard ratio, 0.96; 95% CI, 0.86–1.07) (Fig. 2).

Beginning in 2001, a rapid increase in the proportion of fractures treated with intramedullary nails was observed, peaking at 65% in 2007. From 1993 to 2000, less than 10% of intertrochanteric hip fractures were treated with intramedullary nails. This rapid increase in intramedullary nail fixation was seen in for-profit, nonprofit, and government-owned hospitals. (Fig. 3).

Surgical time for nailing declined rapidly after 2000. From 1993 to 1999, the mean surgical time required for intramedullary nail fixation of intertrochanteric fractures was 124 minutes (95% CI, 111–137 minutes) compared

Fig. 1A–B Survival curves for complication rates from (A) 1993 to 1999 and (B) 2000 to 2007 show that complications in reoperations occurred more frequently before 2000, but these differences were not significant after 2000.

Fig. 2A–B Survival curves for (A) 1993 to 1999 and (B) 2000 to 2007 show that 1-year mortality had worse outcomes for recipients of nails, but these differences were not significant after 2000.

Fig. 3 Trends in the use of intramedullary nails and sliding screw plates from control samples of Medicare beneficiaries in SEER regions from 1993 to 2007 are shown. The proportions of intramedullary nail use increased across all hospital types. FP = for profit; NFP = not-for-profit; Gov = government.

Fig. 4 Trends in surgical time for intramedullary nails and sliding screw plates from control samples of Medicare beneficiaries in SEER regions from 1993 to 2007 are shown. Surgical time was derived from the median time from the anesthesiologist's claim.

with 88 minutes (95% CI, 86–89 minutes) for plate-and-screw fixation. From 2000 to 2007, the mean surgical time for intramedullary nail fixation showed a 42% improvement to 71 minutes (95% CI, 70–73). The mean surgical time for plate-and-screw fixation also experienced an improvement to 70 minutes (95% CI, 69–72 minutes). A gradual decline in the median surgical time was seen between 1997 and 2001 (Fig. 4).

Intramedullary nail fixation has been reimbursed consistently at a rate higher than plates and screws (Fig. 5), yet use of nails was uncorrelated with reimbursement differences. Before 1999, plates actually were reimbursed 11% less than nails (range, 11.1%–11.6%), but from 1999 onward, plates were reimbursed 20% less than nails (range, 18.1%–20.2%). In 2000, there was a cut to the total Medicare RVU assignment for plate-and-screw fixation as calculations transitioned from a charge-based value method to a resource-based method for the practice and malpractice

expense components. On average, actual reimbursements for intramedullary nail fixation were 18% more than the reimbursements for plate-and-screw fixation. Adjusted for inflation, the reimbursement for both procedures has declined 16% since 2002.

Discussion

In this study, we found there was an improvement in outcomes with the use of intramedullary nails. Its rates of revision surgery and mortality were not significantly different from those for sliding hip screws since 2000. We also found nails have been used uniformly across multiple hospital ownership types with presumably different cost structures, and have become as efficient as the traditional procedure. In the actual and intended reimbursements, although nails may have been more favorably reimbursed, this remained in times of low and high use. These findings suggest that additional factors in addition to reimbursement incentives were involved in increased use of intramedullary nails.

Our study has several limitations. First, although administrative data are strong for identifying nationwide trends and rates of return to the operating room, no clinical (such as functional outcomes) or radiographic data are available. Certain outcomes, such as severe shortening treated with a shoe lift, would not be identified. Although we have data regarding ownership status of each hospital, we have no data regarding payment structures for the physicians. Finally, one reasonable interpretation of these data is that these improvements resulted in clinical equivalence of the two procedures, which then allowed nonclinical factors to sway decision-making. Our data can neither prove nor disprove this theory but in the least

Fig. 5 The mean Medicare payments (in US dollars) to surgeons and total relative value units for the two procedures are shown. Differences in reimbursement between intramedullary nails and plates were substantial for all years except 1993 and 1998. The error bars indicate the 95% CIs. Dollars were Consumer Price Index-adjusted to 2007. RVU (relative value unit) information was derived from the annual final ruling for physician fee schedules by the Centers of Medicare & Medicaid Services recorded in the Federal Register.

confirm that no detriment (in terms of complications) is currently occurring in the switch to intramedullary nailing.

Medicare claims data have been used to study trends in intertrochanteric fracture fixation. Forte et al. [7] used a 100% sample to study factors associated with nailing and found that surgeons using nails were younger, whereas hospitals using nails were more often teaching hospitals. Using a 20% Medicare sample from 1999 to 2001, Aros et al. [3] found that nailing may result in higher complication rates and expressed concern considering higher reimbursements.

However, that study captured a transitional period and likely does not include many newer technologies. The original Gamma[®] Nail (Stryker, Mahwah, NJ, USA) was introduced in the United States in 1988 and Smith & Nephew (London, UK) launched the Intramedullary Hip Screw in 1991. Although there was initial concern for fracture at the tip of the Gamma nail, outcomes improved with a second-generation Gamma nail in 1997 [5]. However, the results of these obsolete designs are still incorporated into current meta-analyses. The most recent Cochrane review that was in favor of plate-and-screw fixation relied heavily on studies of these two products [14].

After this period, there was a boom in the market for new cephalomedullary nail devices. Smith & Nephew launched Trigen[™] Nails in 1999, advertising a trapezoidal nail profile and multiple interlocking screws. DePuy Orthopaedics (Warsaw, IN, USA) launched the ATN[®] trochanteric nail in 2001, boasting a new alloy, closely spaced antirotation screws, color-coded instrument trays, and radiolucent insertion and targeting jigs. Synthes (Paoli, PA, USA) introduced the Trochanteric Fixation Nail in 2002, which includes a helical blade, lateral entry point, and new titanium alloy material. Stryker also updated the Gamma[®] Nail in 2003, incorporating a new alloy and short and long designs. Few studies exist regarding these design

changes, but we speculate that the release of these improved nail designs (whether real or simply for marketing), along with their accompanying more surgeon-friendly instrumentation and the ability to be inserted with and without reaming, contributed to the rapid increase in the use of intramedullary nails. It is likely that increased marketing efforts at the time of release of the new nail design also raised awareness of the suitability of intramedullary nails for hip fractures.

Although studies have failed to show a consistent benefit for intramedullary nail fixation over plate-and-screw fixation for intertrochanteric hip fractures [1, 4], newer studies no longer show a greater complication risk [13, 18, 20]. In a meta-analysis of the Gamma nail alone, the increased risks of complications of earlier designs of the Gamma nail were resolved when considering only studies from 2000 to 2005 [5]. Our study agrees with the findings of Bhandari et al. [5] and is the first to show an improvement in outcomes from an epidemiologic perspective.

Bozic and Jacobs cited the reimbursement difference as the cause for a shift toward intramedullary nails [6], but we believe the explanation for the shift toward intramedullary nails is much more benign than that of reimbursement alone. We found that intramedullary nail use increased beginning in 2001 and occurred simultaneously across all hospital ownership types. Although initially a much longer procedure, the time required for intramedullary nailing decreased substantially. Intramedullary nail use had been associated with higher risks of complications and mortality before 2000, but since 2000, these differences have disappeared. It is likely that as surgeons gained experience with nailing in the late nineties, more residents were trained in their use and chose to use them as they moved into independent practice [2].

For-profit hospitals frequently have been the early adopters as they have more capital to invest in newer

technologies as a form of nonprice competition [9]. For-profit hospitals were the earliest to use these newer orthopaedic technologies. Although the surgeons at these hospital types may be under varying compensation schemes, a similar shift in practice in the same period was seen for surgeons in countries that are paid according to salary systems [15]. This would imply a motive separate from simple profit.

Furthermore, reimbursement differences existed in periods of low and high use, and the difference varied between \$152 (US dollars) and \$276 for a procedure that reimburses approximately \$1500. This is contrast to the controversy behind spinal fusions and decompressions for symptomatic degenerative lumbar spine, which involves \$928 for decompression versus \$2265 for arthrodesis, instrumentation, and bone grafting [19].

Incentive also may arise from the recognition of relative indications to use intramedullary nails. Studies since 2000 have shown that certain subtypes of intertrochanteric fractures benefit from intramedullary nail fixation, including reverse obliquity fractures [10] (estimated to account for 5% of all intertrochanteric and subtrochanteric fractures) and fractures involving the lateral wall of the proximal femur [10, 12]. Although not necessarily universally agreed on, recognition of these fracture patterns could serve to positively encourage use of intramedullary nails. Finally, there has been extensive surgeon education on the technical aspects of intramedullary nailing of intertrochanteric fractures, which has likely improved outcomes [10].

Intramedullary nailing of intertrochanteric fractures appears to have become a safer procedure since 2000. Although financial incentives were not necessarily absent, they alone would not explain the improved procedural efficiencies and outcomes. The simultaneous introductions of newer technologies along with increasing experience of early users could have played a role. From a macroscopic perspective, intramedullary nail fixation as a whole has improved, and although it remains an expensive implant for the hospital and may be less cost-effective, at this point, use of the intramedullary nails does not come at a cost to patient outcomes. The equality of operating room time and outcomes supports the notion that reimbursement for the two procedures should be equalized. Reimbursement differences were eliminated in 2009, so study of future trends will prove interesting.

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