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■ THE HIP SOCIETY

Total hip arthroplasty following failed intertrochanteric hip fracture fixation treated with a cephalomedullary nail

Aims

Cephalomedullary nails (CMNs) are commonly used for the treatment of intertrochanteric hip fractures. Total hip arthroplasty (THA) may be used as a salvage procedure when fixation fails in these patients. The aim of this study was to analyze the complications of THA following failed intertrochanteric hip fracture fixation using a CMN.

Patients and Methods

Patients who underwent THA were identified from the 5% subset of Medicare Parts A/B between 2002 and 2015. A subgroup involving those with an intertrochanteric fracture that was treated using a CMN during the previous five years was identified and compared with the remaining patients who underwent THA. The length of stay (LOS) was compared using both univariate and multivariate analysis. The incidence of infection, dislocation, revision, and re-admission was compared between the two groups, using multivariate analysis adjusted for demographic, hospital, and clinical factors.

Results

The Medicare data yielded 56 522 patients who underwent primary THA, of whom 369 had previously been treated with a CMN. The percentage of THAs that were undertaken between 2002 and 2005 in patients who had previously been treated with a CMN (0.346%) more than doubled between 2012 and 2015 (0.781%). The CMN group tended to be older and female, and to have a higher Charlson Comorbidity Index and lower socioeconomic status. The mean LOS was 1.5 days longer (5.3 vs 3.8) in the CMN group ($p < 0.0001$). The incidence of complications was significantly higher in the CMN group compared with the non-CMN group: infection (6.2% vs 2.6%), dislocation (8.1% vs 4.5%), revision (8.4% vs 4.3%), revision for infection (1.1% vs 0.37%), and revision for dislocation (2.2% vs 0.6%).

Conclusion

The incidence of conversion to THA following failed intertrochanteric hip fracture fixation using a CMN continues to increase. This occurs in elderly patients with increased comorbidities. There is a significantly increased risk of infection, dislocation, and LOS in these patients. Patients with failed intertrochanteric hip fracture fixation using a CMN who require THA should be made aware of the increased risk of complications, and steps need to be taken to reduce this risk.

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Hip fractures are common, with 1.6 million occurring annually worldwide and a predicted worldwide occurrence of 6.3 million by 2050.^{1,2} A total of 280 000 hip fractures occur annually in the United States and 36 000 in Canada. These numbers are expected to increase to more than 500 000 and 88 000, respectively.^{3,4} Approximately 50% of these fractures are intertrochanteric,⁴ for which optimal management remains controversial. Cephalomedullary nail (CMN) fixation has

become increasingly used and has surpassed the dynamic hip screw (DHS) as the preferred method of treatment.^{5–10} Recent studies have reported similar incidences of perioperative fracture and clinical outcomes between intramedullary and sliding screw fixation.^{4,6,11–13} Complications following the surgical treatment of intertrochanteric fractures include nonunion, malunion, avascular necrosis, fracture collapse with intra-articular screw migration, and post-traumatic osteoarthritis.¹⁴

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Conversion to THA following failed intertrochanteric hip fracture fixation has an increased incidence of complications such as dislocation and periprosthetic fracture, with increased costs.¹⁴⁻¹⁸ Comparing DHS with CMN, previous authors have found that conversion to THA following CMN fixation has longer operating time, increased blood loss, and an increased incidence of perioperative complications.^{5,19-21} The aim of this study was to identify specific complications, including re-admission and revision, in patients undergoing THA following failed treatment of an intertrochanteric fracture using a CMN.

Patients and Methods

Patients who had a THA (International Classification of Diseases (ICD) code 81.51)²² between 2002 and 2005, as well as five years of prior claim history, were identified from the 5% subset of Medicare Part A (inpatient) data.²³ This subset is collected from a sample of patients with identification numbers, for which the digits are randomly selected. These data are collected until these patients die. Using the corresponding Medicare Part B (professional/physician) data for patients who undergo THA, those who had been treated with a CMN for an intertrochanteric fracture in the previous five years were identified and compared with the remaining patients who had undergone primary THA. CMN was identified using Current Procedural Terminology (CPT) code 27245. The diagnosis of an intertrochanteric hip fracture was based on ICD, Ninth Revision, Clinical Modification (ICD-9-CM) codes (820.20, 820.21) before 1 October 2015 or Tenth Revision (ICD-10-CM) codes (S72.101A, S72.102A, S72.109A, S72.141A, S72.142A, S72.143A, S72.144A, S72.145A, S72.146A) after 1 October 2015. Patients who had an intertrochanteric fracture in the five years before undergoing THA, but who were not treated with a CMN, were excluded. Those whose medical history for the five years before undergoing THA was not available were also excluded.

Length of stay (LOS) after THA, infection, dislocation, revision, and re-admission up to two years postoperatively were compared between those with and without prior CMN. Infection was identified using ICD-9-CM code 996.66 or ICD-10-CM codes T84.50XA, T84.51XA, T84.52XA, and T84.59XA, while dislocation was identified using ICD-9-CM codes 996.42, 835.0x, and 718.35, or ICD-10-CM codes T84.020, T84.021, and T84.029. Revision surgery for any indication was identified from CPT codes 27134, 27137, and 27138. Revision for infection or dislocation as diagnostic codes were also considered as outcomes.

Statistical analysis. Infection, dislocation, revision, and re-admission were evaluated using multivariate Cox regression analysis, adjusted for various demographic, hospital, and clinical factors. Covariates in the model included age at time of THA, Medicare buy-in status, race, census region, sex, Charlson Comorbidity Index (CCI),²⁴ discharge status following THA, number of hospital beds, hospital ownership, hospital teaching status, LOS after THA, year of THA, a previous diagnosis of diabetes, obesity and heart disease (using the relevant ICD-9-CM or ICD-10-CM codes), and previous CMN for an intertrochanteric fracture. The Medicare buy-in status is a proxy for socioeconomic status, as it indicates whether the patient

received state subsidies for their premiums. LOS was compared using univariate Student's *t*-test, followed by multivariate Poisson regression with the above-mentioned covariates (SAS 9.4 statistical software; SAS Institute, Cary, North Carolina).

Results

The Medicare data yielded 56 522 patients who had undergone primary THA, of whom 369 (0.65%) had previously been treated with CMN. The incidence of THA after CMN between 2002 and 2005 (0.342%) subsequently more than doubled to 0.786% between 2012 and 2015. The CMN group tended to be older and female, and to have a higher CCI score and lower socioeconomic status (Fig. 1). The mean LOS was 5.3 days (SD 3.5) in the CMN group and 3.8 days (SD 2.4) in the control group ($p < 0.0001$). The adjusted LOS was 23.7% (95% confidence interval (CI) 18.3 to 29.4) longer in the CMN group (multivariate, $p < 0.0001$).

The rate of postoperative complications within two years was higher in the CMN group, compared with the non-CMN group: infection (6.2% vs 2.6%), dislocation (8.1% vs 4.5%), revision (8.4% vs 4.3%), revision for infection (1.1% vs 0.37%), and revision for dislocation (2.2% vs 0.6%) (Fig. 2). The two-year adjusted risks of infection, dislocation, revision, revision for infection, and revision for dislocation were significantly higher for the CMN group by 125% (95% CI 40 to 261; $p < 0.001$), 95% (95% CI 32 to 188; $p < 0.001$), 181% (95% CI 95 to 307; $p < 0.001$), 379% (95% CI 74 to 1217; $p = 0.002$), and 321% (95% CI 104 to 766; $p < 0.001$), respectively. The main indication for revision in both groups, two years postoperatively, was dislocation (Table I). The risk of re-admission was also significantly higher in the CMN group by 21% at three months (95% CI 1 to 45; $p = 0.041$) and by 20% at six months (95% CI 1 to 42; $p = 0.038$).

Discussion

The overall number of intertrochanteric fractures continues to increase, reflecting our increased life expectancy. Conversion to THA is the most common form of treatment in elderly patients following the failed intertrochanteric hip fracture fixation. This is a complex procedure without the predictable outcomes of THA for osteoarthritis. We used a large Medicare database to examine the trends and complications following conversion to THA after failure of CMN fixation for an intertrochanteric fracture. We identified infection (6.2%) and dislocation (8.1%) as the most common indications for revision surgery. THA under these circumstances can be difficult for many reasons including proximal femoral malunion, retained hardware, and trauma to the soft tissues and abductors, often resulting in dense scarring and occasionally heterotopic bone. The exposure and removal of hardware in these patients can be difficult with long operating time and increased blood loss. This procedure may need, therefore, to be staged in some patients.

The choice of implants for the THA has to be based on many factors including the extent of proximal femoral bone loss, the presence of malunion that may require osteotomy, and the quality of the bone. The surgical goals are to restore leg length and offset, and to provide stability. Other authors have published

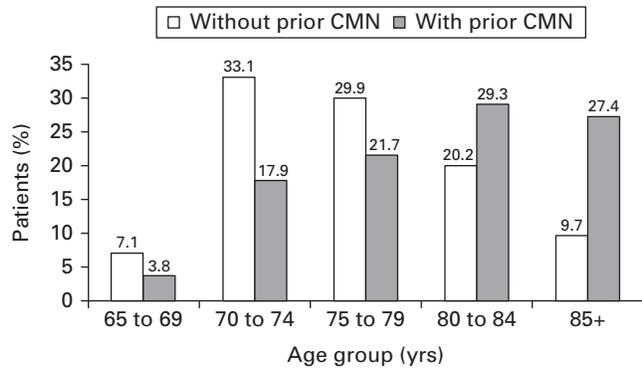


Fig. 1a

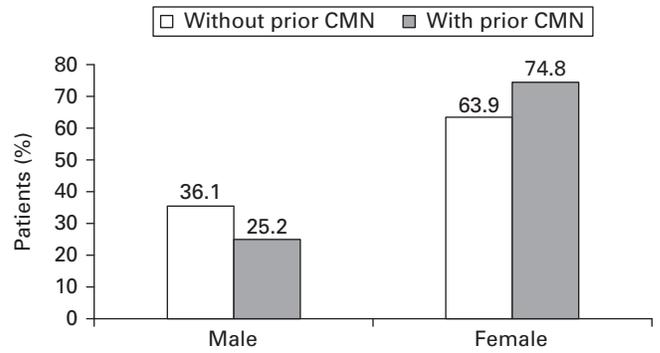


Fig. 1b

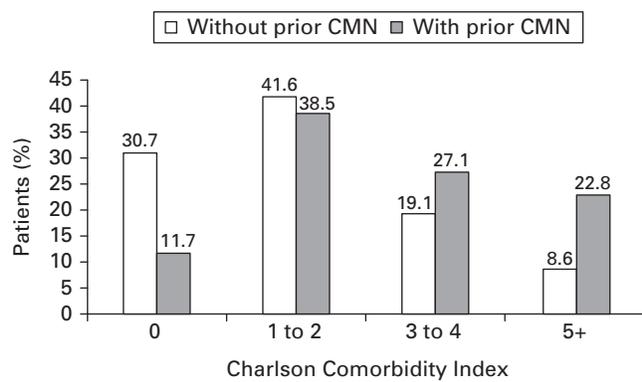


Fig. 1c

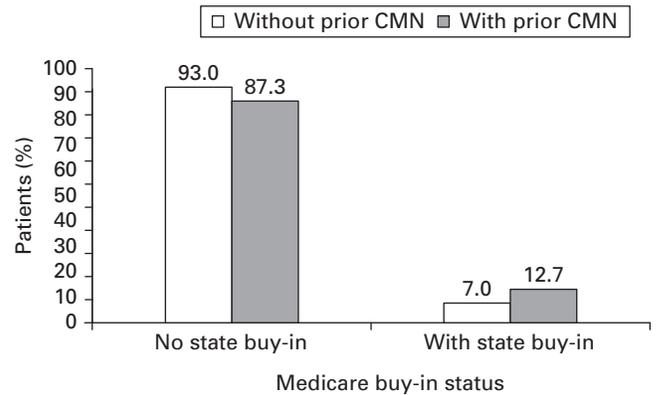


Fig. 1d

Graphic charts showing: a) age distribution of patients undergoing total hip arthroplasty (THA) with or without prior cephalomedullary nail (CMN); b) distribution of sex for patients undergoing THA with or without prior CMN; c) Charlson Comorbidity score distribution of patients undergoing THA with or without prior CMN; and d) socioeconomic status distribution of patients undergoing THA with or without prior CMN with state buy-in representing lower socioeconomic status.

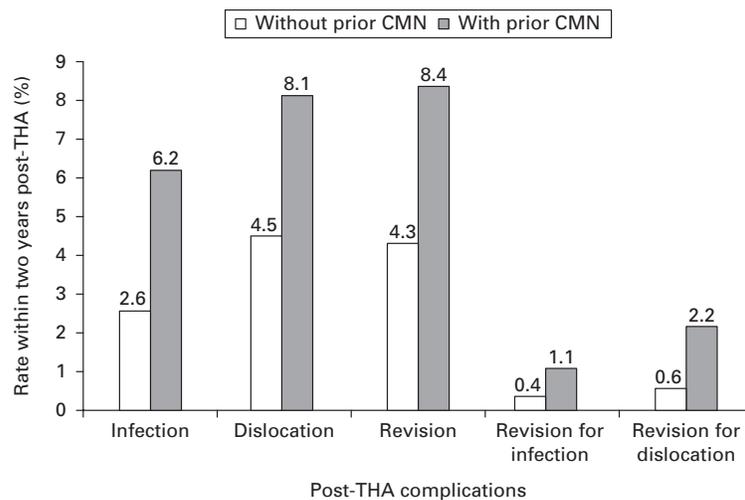


Fig. 2

Graphic chart demonstrating incidence of postoperative complications following total hip arthroplasty (THA) with or without prior cephalomedullary nail (CMN) at two years following surgery.

Table I. The main indication for revision

Diagnosis code	Description	n (%)
With prior CMN		
996.42	Dislocation of prosthetic joint	9 (30.0)
996.66	Infection and inflammatory reaction due to prosthesis	3 (10.0)
V57.89	Care involving other specified rehabilitation procedure	3 (10.0)
599.0	Urinary tract infection, site not specified	2 (6.7)
996.49	Other mechanical complication of orthopaedic device, implant, or graft	2 (6.7)
358.01	Myasthenia gravis with (acute) exacerbation	1 (3.3)
427.32	Atrial flutter	1 (3.3)
427.81	Sinoatrial node dysfunction	1 (3.3)
453.41	Acute venous embolism and thrombosis of deep vessels of proximal lower limb	1 (3.3)
482.9	Bacterial pneumonia, unspecified	1 (3.3)
Without prior CMN		
996.42	Dislocation of prosthetic joint	190 (13.1)
996.4	Mechanical complication of orthopaedic device, implant, or graft	151 (10.4)
V57.89	Care involving other specified rehabilitation procedure	149 (10.2)
996.44	Periprosthetic fracture	137 (9.4)
996.41	Mechanical loosening of prosthetic joint	106 (7.3)
996.66	Infection and inflammatory reaction due to prosthesis	97 (6.7)
996.47	Other mechanical complication of prosthetic joint implant	51 (3.5)
996.77	Other complications due to prosthesis	45 (3.1)
715.35	Osteoarthritis, localized, not specified whether primary or secondary, pelvic region and thigh	39 (2.7)
996.43	Fracture of prosthetic joint	26 (1.8)

CMN, cephalomedullary nail

small retrospective studies reporting on conversion to THA following failed fixation of an intertrochanteric fracture with similar results. Archibeck et al²⁵ reviewed THA after failed fixation of proximal femoral fractures at a single institution between 1987 and 2008. Of their 102 patients, 39 had a previous intertrochanteric fracture and, of those, only three were treated with CMN. For their entire cohort, the early complication rate was 11.8% with a dislocation rate of 4.9%. The rates of periprosthetic fracture and dislocation were higher when converting intertrochanteric fractures compared with intracapsular fractures. Tetsunaga et al²⁶ undertook a similar retrospective review of 50 patients who underwent conversion to THA following failed fixation of a proximal femoral fracture. They found no complications following intracapsular fractures, but a 25% complication rate following intertrochanteric fractures. The incidence of periprosthetic fracture and dislocation was 9.4% and 6.3%, respectively. The incidence of infection was 6.3% and there was one stem perforation (3.1%). Zhang et al¹⁶ described a series of 19 patients who underwent conversion to THA following failed intertrochanteric hip fracture fixation. Their complication rate was high at 47%. The incidence of intraoperative periprosthetic fracture and dislocation was 32% and 16%, respectively.

D'Arrigo et al²⁷ reviewed 21 patients who underwent conversion to THA following failed intertrochanteric fracture fixation. They recorded a much lower complication rate, with only one intraoperative fracture that required cabling and no dislocations. Lee et al²⁸ reviewed 33 patients who underwent conversion to

THA following failed intertrochanteric hip fracture fixation, 19 of whom had been treated with a CMN. They reported five intraoperative periprosthetic fractures, but no dislocations. Pui et al²⁰ performed a multicentre study with 91 patients who underwent conversion to THA following failed intertrochanteric hip fracture fixation, 31 of whom had been treated with a CMN. The complication rate in the CMN group was significantly higher at 41%, compared with 11.7% in the sliding hip screw group ($p = 0.001$). Periprosthetic fracture and dislocation were the most common complications.

Using the Medicare database, we were able to report on the largest series in the literature of patients undergoing conversion to THA following failed intertrochanteric hip fracture fixation using a CMN. We found an approximately three-fold increase in the incidence of conversion to THA in patients treated with a CMN during the early period of the study (2002 to 2005) compared with the recent years (2012 to 2015). Patients requiring this procedure were older, had a higher CCI score, and had a lower socioeconomic status, which are known risk factors for malunion and nonunion. However, even when adjusting for these comorbidities, those who underwent conversion had a longer LOS than patients who underwent primary THA. This is likely to be due to the more extensive surgery that is required.

As with the other studies on this subject, postoperative complications were higher in those who had previously been treated with a CMN compared with those undergoing routine primary THA. The incidence of infection and dislocation were both

close to double in the CMN group. The incidence of infection was significantly greater in the conversion group. This could be related to the presence of hardware, the extensile exposure, longer operating time, and higher comorbidities in these patients. It is important to rule out infection as a cause of failure of fixation prior to conversion to THA. As this is a high-risk group of patients, steps must be undertaken intra- and postoperatively to minimize the risk of infection.

The cause of dislocation following conversion to THA in these patients is multifactorial. There may be comminution and malunion of the initial fracture leading to abductor deficiency and compromised function, increasing the risk of dislocation. The insertion of a CMN through the trochanter can also damage and compromise the abductor muscles. Attention must be paid to restoring leg length and offset in order to reduce the risk of dislocation. This may require the use of modular femoral stems, trochanteric osteotomy, and possibly dual-mobility acetabular components. We did not have detailed information about the type of implants that were used, nor were radiographs available; these are limitations of large database studies. We also did not have specific surgical information to identify the incidence of periprosthetic fractures that other authors have identified, given the proximal femoral deformity in patients with failed intertrochanteric hip fracture fixation. As our population continues to age, patients requiring conversion to THA after failed intertrochanteric hip fracture fixation using a CMN will continue to increase. Surgeons must recognize the increased risk of complications and take preventive steps to minimize them in this high-risk group of patients.



Take home message

- There is a significantly increased risk of infection, dislocation, and length of stay in patients undergoing conversion to total hip arthroplasty following failed intertrochanteric hip fracture fixation using a cephalomedullary nail.

- Patients undergoing this procedure should be aware of the increased risks and should be provided with appropriate counselling. Surgeons should also be aware of the increased risks and take preventive steps to minimize them.

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E. Lau: Designed the study, Acquired and analyzed the data, Edited the
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