

# Safety and Efficacy of a Single-Stage versus Two-Stage Intramedullary Nailing for Synchronous Impending or Pathologic Fractures of Bilateral Femur for Oncologic Indications: A Systematic Review of Literature

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**INTRODUCTION:** Intramedullary nail (IMN) fixation is a common surgical treatment for patients with metastatic bone disease of the femur. The femur is the most common long bone involved and bilateral synchronous impending and/or complete pathologic femur fractures may be present in patients with advanced metastatic disease. Single-stage bilateral femur IMN raises concern of increased complications and mortality. However, advantages include single anesthesia, expedited mobilization, early start of adjuvants, reduced length of stay and decreased overall cost. Although few recent studies have shown encouraging results, they are limited by their study design, and thus the optimal surgical timing (single- vs. two-stage) remains controversial. Therefore, the objective of this study was to conduct a systematic review of the existing literature regarding the outcomes after single-stage (SS) and two-stage (TS) IMN fixation of bilateral femora for oncologic indications.

**METHODS:** The literature search was conducted based on the PRISMA guidelines. We queried four electronic databases (Medline/PubMed, EMBASE, Scopus, and the Web of Science) up to February 2023. Eligible studies reporting on outcomes of SS vs. TS bilateral femoral IMN procedures in patients with synchronous pathologic or impending fractures, were included. Studies were excluded if IMNs were done for non-oncologic indications, metachronous bilateral femur disease and/or performed during different admissions (defined as > 12 weeks if not specified), data was insufficient or unavailable, non-IMN fixation methods (e.g., arthroplasty, plating, dynamic hip screw, isolated cementoplasty, flexible nails, or tumor prosthesis) were utilized, and if details regarding staging and outcomes were unspecified. The information (if reported) retrieved from each publication included: (1) general study information (e.g., author, title, study design, year of publication); (2) SS vs. TS; (3) patient demographics (e.g., age, sex, primary tumor, etc.); (4) details of the surgical procedure (including type and size of nail used, surgical technique (e.g., canal venting, diaphyseal reaming, cement use, distal locking screw utilization, reaming irrigation aspiration [RIA]), time delay between the first and second femoral IMN for TS cases); (5) outcome measures of patient safety (complications, reoperations, mortality, survival, blood loss and transfusion); and (6) outcome measures of efficacy (length of stay [LOS], time to start rehabilitation and adjuvant therapy, functional scores and cost).

**RESULTS:** Out of 1972 publications, 14 eligible studies met inclusion criteria. These studies reported on 156 IMN inserted in 78 patients. Thirty-six (46.2%) patients underwent SS bilateral IMN fixation, and 42 (53.8%) patients underwent a TS procedure. No study showed any difference in outcomes with nail type (solid vs hollow), IMN technique, reaming or venting. Medical and surgical complications were reported in 9 publications for 34 in the SS and 24 patients in TS group. Total complications were reported in 5 of 34 (14.7%) in the SS and 11 of 24 (45.8%) patients in the TS group (p=0.021) and were mostly medical complications [5 (14.7%) vs 10 (41.6%); p=0.045]. Cardiopulmonary complications were the most commonly reported medical complications in each group, with no statistically significant differences in the proportion of cardiopulmonary to medical complications between the SS and TS cohorts [5/5 (100%) vs 7/10 (70.0%); p=0.494]. There were no surgical complications in the SS but 1 (4.2%) deep wound infection requiring return to the operating room for surgical debridement occurred in the TS group (p=0.86). There were no nail failures in either group. Length of survival did not differ significantly between the SS and TS cohort when reported for 30 days or longer (p=0.530) or 90 days or longer (p=1.000). There was no significant difference in rates of total same-admission (intraoperative + postoperative) mortality between the SS and TS cohort. There was no significant difference in blood loss between the SS and TS cohorts. No definitive comparison could be made regarding blood transfusion between SS vs TS cohorts, as data was not clearly available in any study. LOS has been shown in one study to be shorter in the SS cohort (7.3±4.5 [range, 1–14] days) compared to the TS cohort (21.3±18.1 [range, 3–65] days) [p=0.006]. No definitive comparison could be made regarding time to rehabilitation, adjuvant therapy, functional scores and cost, as no papers reported on these data.

**DISCUSSION:** Our systematic review supports a single stage bilateral femoral nailing procedures as a reasonable surgical treatment strategy in select patients with synchronous complete and/or impending pathologic fractures of the bilateral femur. Compared with a TS approach, SS offered several benefits including comparable survival, same-admission mortality, blood loss, with lower complication rates and likely shorter LOS, which supports this strategy in providing definitive early surgical fixation while aiming to expedite adjuvant treatment and rehabilitation required in this patient population. Though ours is the most comprehensive analysis of its kind with encouraging results, it is limited by selection bias in staging decisions and heterogenous data; thus, larger and higher-level evidence studies are required to further delineate optimal treatment guidelines for these unique but increasing number of patients.

**SIGNIFICANCE/CLINICAL RELEVANCE:** The current study is the most comprehensive one of its kind and supports a SS bilateral femoral nailing procedures as a reasonable surgical treatment strategy in select patients with synchronous complete and/or impending pathologic fractures of the bilateral femur. secondary to oncologic indications.

## IMAGES AND TABLES:

Figure 1. PRISMA flowchart depicting the article selection process for the investigation.

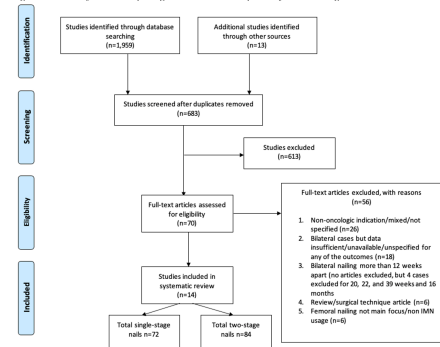


Figure 2. Kaplan-Meier curves depicting the survival of patients who underwent bilateral femur intramedullary nail fixation in single-stage or two-stage

