Single-stage versus Multi-stage Intramedullary Nailing for Multiple Synchronous Long Bone Impending and Pathologic Fractures in Metastatic Bone Disease and Multiple Myeloma

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INTRODUCTION:

Advanced metastatic disease may present with synchronous involvement of multiple long bones, often requiring fixation with intramedullary nails (IMN) for impending or pathologic fractures. The optimal timing of multiple bone fixation, whether in a single- or multiple-stage setting, is still highly debatable. Historically, literature has cautioned against intramedullary nailing of multiple long bones in the same operative setting due to high morbidity and mortality rates often due to cardiopulmonary complications associated with intramedullary nail placement. Although a few small early reports described higher rates of complications with a single-stage surgery, some contemporary studies have supported the use single-stage nailing, but still lacked comprehensive comparative analyses. Nailing of multiple long bones in the same surgical setting in select patients may decrease operating room logistics, lead to faster mobilization, discharge and early resumption of adjuvant therapies, and decrease overall costs. Thus, the purpose of this study is to determine whether perioperative outcomes differ significantly between cohorts of patients who have undergone single or multi-stage nailing procedures.

METHODS:

This was a retrospective review of an Institutional Review Board (IRB)-approved prospectively maintained database of a musculoskeletal oncology/adult reconstruction fellowship-trained surgeon in a single academic urban orthopaedic residency program. Patients with metastatic long-bone diseases who underwent IMN placement between April 2011 and December 2020 were classified into single-stage single bone (SSSB), single-stage multiple-bone (SSMB), and multi-stage multiple-bone (MSMB) groups based on the procedure timing and number of bones involved. Outcome variables compared between the three groups included intraoperative estimated blood loss (EBL), blood transfusions (PRBC), postoperative length of stay, postoperative survival, return to adjuvant therapy, initiation of rehabilitation, perioperative complications, and in-hospital mortality. A one-way analysis of variance (ANOVA) with post-hoc Tukey was conducted to compare the means of continuous variables among the groups, including patient age, BMI, EBL, PRBC, and hospital length of stay. A Fisher's exact test with a Freeman-Halton extension was performed to compare categorical variables between the study cohorts, including sex, type of fracture, location of fracture, complications, and death. Survivorship analyses were conducted using a log-rank test with Kaplan-Meier estimates, and patients who were lost to follow-up were censored.

RESULTS:

There were 272 IMNs placed in 181 metastatic long-bone disease patients (100 [55.2%] males and 81 [44.8%] females) with a mean age of 66.3±12.1 years. No significant differences were detected in survival (SSSB: 8.1±8.6, SSMB: 7.1±7.2, and MSMB: 11.4±11.8 months) and in-hospital mortality rate (SSSB: 5 of 111 [4.5%], SSMB: 4 of 45 [8.9%], and MSMB: 1 of 25 [4.0%]) between the study cohorts (both, $p>0.05$). Although perioperative complication rates in SSMB and MSMB cohorts were comparable (33.3% vs 36.0%), SSSB patients had a significantly lower (18.0%) rate ($p=0.038$). Likewise, compared to the SSSB group, SSMB and MSMB patients had significantly higher EBL (219±134 [range, 50 – 750], 424±190 [range, 200 – 1000], and 467±238 [range, 100 – 1000] mL). MSMB patients had significantly lengthier hospital stay (24.3±14.2 days) and rehabilitation initiation (3.4±2.5 days) compared to SSSB (8.5 ± 7.7 and 1.8±1.6 days) and SSMB (11.5±7.6 and 2.0±1.6 days) subjects, respectively (both; $p < 0.01$).

DISCUSSION AND CONCLUSION:

Single-stage multiple intramedullary nailing of synchronous long-bone metastases in select patients does not increase their risk of perioperative complications and in-hospital mortality but leads to earlier postoperative discharge and initiation of rehabilitation. This argues against mandatory staging of all multiple-bone nailing procedures and adds to the growing literature supporting the use of SSMB strategy. Despite our study being the largest and most robust to date with encouraging results, our sample size is still relatively small. In the absence of definitive guidelines and protocols, the final decision for the surgery setting (SSMB versus MSMB) was made at the discretion of the attending surgeon and multidisciplinary team, which may have led to systemic selection bias as not all patients included in the study were deemed fit for single-stage procedures. Larger studies are needed to validate our results.