Intramedullary Nailing With and Without the Use of Bone Cement for Impending and Pathologic Fractures of the Humerus in Multiple Myeloma and Metastatic Disease

Patrick P. Nian[1], Joydeep Baidya[1], Andriy Kobryn[1], Vanathi Ganesan[1], Tai L. Li[1], Chibuokem P. Ikwuazom[1], Aditya V. Maheshwari[1]
[1]Department of Orthopaedic Surgery, SUNY Downstate Health Sciences University, Brooklyn, NY
Email of Presenting Author: patrick.nian@downstate.edu

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INTRODUCTION: Although intramedullary nailing (IMN) is considered the standard of care for the surgical management of most femur metastatic diseases, the optimal treatment of metastatic humeral impending and/or pathologic fractures is still debatable. The treatment is influenced by multiple factors, including lesion location and severity, bone quality, presence of complete fracture, and overall patient health. Use of bone cement with IMN has been shown to promote fixation, provide greater construct stability, reduce local tumor mass, resume early adjuvant treatment, and slow disease progression. However, some consider cement unnecessary due to increased complications, operative time, adequate stability with the nail alone, possible neurovascular damage secondary to the cement's thermogenic effect and soft-tissue extrusion, and slower bony healing. Nevertheless, the use of cemented humeral nails has not been well studied, and only a few small series have compared their results with uncemented nails. Moreover, most studies have not distinguished if the bone cement was used just to fill the tumor cavity or the entire intramedullary canal (cemented IMN as defined in our study). Thus, the purpose of this study was to analyze the (1) survivorship, (2) functional outcomes, and (3) perioperative complications in patients receiving humerus IMN for impending or complete pathologic fractures resulting from metastatic disease or multiple myeloma, and to compare these outcomes in cemented versus uncemented groups.

METHODS: We retrospectively reviewed a single-surgeon database in an urban academic setting from August 2011 to July 2022, and analyzed 100 humeral IMNs in 82 adult patients with impending or complete pathologic fractures, of which 53 were cemented and 47 were uncemented. The use of cement predominantly depended on the extent of tumor involvement, bone quality, amount of bone loss, periarticular lesions, extensive and skip lesions, and fixation stability. Extracted variables included patient demographics, primary malignancy, fracture type (impending or complete pathologic), lesion location, cement use, concomitant procedures (e.g., other long bone IMN in the same or different setting), blood loss, blood transfusion, perioperative medical and surgical complications, return to operating room (ROR), patient survivorship, and Musculoskeletal Tumor Society (MSTS) upper extremity functional scores. Descriptive and statistical analyses, including 2-sided Fisher's exact and Student's t-tests to compare categorical and continuous variables, respectively, and Kaplan-Meier estimates of patient survivorship were performed in R Statistical Software using a p-value of <0.05 as threshold for statistical significance.

RESULTS SECTION: Mean survivorship for all available patients was 10 ±14.3 months [range, 1–86] (Cemented: 8.3 ±9.3 [range, 1–35] vs. Uncemented: 11.6 ±17.7 [range, 1–86] months, p = 0.34). There was no intraoperative mortality but two patients in the cemented group died during same admission at 1 month (p=0.22). The mean MSTS scores increased from 42.4 ±8.4% [range, 28–60] pre-operatively (Cemented: 40.2 ±9.6% [range, 16–64] vs. Uncemented: 66.7 ±28.5% [range, 20–100], p = 0.01) to 89.2 ±5.5% [range, 76–96] at 3-months postoperatively (Cemented: 89.8 ±7.0% [range, 80–100] vs. Uncemented: 90.9 ±1.9% [range, 90–100], p = 0.72) for the overall group (p<0.001). Both cohorts had comparable complication rates (overall [22.6% vs 19.1%)], surgical ([11.3% vs 4.3%] and medical [13.2% vs 14.9%], all p>0.05) and perioperative blood transfusion (204 vs. 271 ml, p = 0.41), but blood loss was significantly higher in the cemented group (203ml vs 126 ml, p=0.003). There were no cases of surgical site infections, wound dehiscence, or nail failure. There were two ROR in the cemented group: one for unrelated cervical spine decompression (2 days) and other for removal of a backed out proximal locking screw (2 years). One planned cemented nail was converted intraoperative to a plate construct due to lateral nail cut out during insertion.

DISCUSSION: IMN with and without cement augmentation in select patients is a relatively safe and effective therapeutic modality for metastatic humeral disease, with similar clinical outcomes and acceptable complication rates. The use of bone cement is often based on several clinical factors and thus induces bias of surgeon decision-making. Most intraoperative surgical complications resulted from technical errors stemming from bone cement use, and could be minimized with awareness, meticulous attention to surgical technique, and increasing experience. While controlling for possible selection bias, larger-scale, higher-level studies are warranted to validate our results.

SIGNIFICANCE/CLINICAL RELEVANCE: The current study supports the utility of IMN with and without cement augmentation for impending and pathologic fractures of the humerus in multiple myeloma and metastatic disease. The study suggests comparative outcomes between cemented and uncemented humeral IMN in terms of survivorship, functional outcomes, and perioperative complications.

IMAGES AND TABLES:

Table 2. Complications, overall survival, and functional outcomes in study patients.

	All Nails N=100 (100%)	Cemented Nails N=53 (100%)	Uncemented Nails N=47 (100%)	P-Value‖
Medical Complications*	14 (14.0%)	7 (13.2%)	7 (14.9%)	0.76
Surgical Complications*	8 (8.0%)	6 (11.3%)	2 (4.3%)	0.47
Overall Complications*	21+ (21.0%)	12+ (22.6%)	9 (19.1%)	1.00
Estimated Blood Loss (ml)§	166±138 (0–1000)	203±179 (0–1000)	126±49 (50–300)	0.003
Single Nail	184±215 (0–1000)	209±238 (0–1000)	100±50 (50–200)	0.046
Multiple Nails-One Setting	149±84 (50–500)	193±110 (100–500)	124±46 (50–300)	0.007
Multiple Nails-Two+ Settings	173±44 (100–200)	183±41(100–200)	164±48 (100–200)	0.45
Perioperative Transfusion (ml)§	236±394 (0–1950)	204±318 (0–975)	271±462 (0–1950)	0.41
Single Nail	115±245 (0–650)	135±270 (0–650)	46±123 (0–325)	0.23
Multiple Nails-One Setting	325±461 (0–1950)	293±348 (0–975)	344±520 (0–1950)	0.67
Multiple Nails-Two+ Settings	175±314 (0–975)	217±394 (0–975)	139±256 (0–650)	0.69
Intraoperative Mortality	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.00
Mortality in the Same Admission	2 (2.0%)	2 (3.8%)	0 (0.0%)	0.22
Preoperative MSTS Score (%)†	42.4±8.4 (28–60)	40.2±9.6 (16–64)	66.7±28.5 (20–100)	0.01
Postoperative MSTS Score at 3 months (%)†	89.2±5.5 (76–96)	89.8±7.0 (80–100)	90.9±1.9 (90–100)	0.72
Survival Time (months)†	10.0±14.3 (0–86)	8.3±9.3 (0–35)	11.6±17.7 (0–86)	0.34

MSTS: Musculoskeletal Tumor Society.
*Reported as sample size (%).
§Reported as mean ± standard deviation (range).
†Reported as mean ± standard deviation (range) after excluding patients lost to follow-up.
+One cemented intramedullary nail procedure exhibited a combination of medical and surgical complications.
‖Reflecting the comparison of variables between patients according to bone cement usage.